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THE WORLD IS ITS FIELD

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PERSONNEL—A VITAL FACTOR IN NAVAL EFFICIENCY.

By Walter M. McFarland.

AN INTRODUCTION TO COMMANDER WORTHINGTON'S PAPER ON NAVAL EDUCATION.

Mr. McFarland is known to naval men all over the world, having long been principal assistant to Admiral Melville, Engineer in Chief of the U. S. Navy. He was also one of the most effective members of the board which reorganized the personnel of the U. S. Navy. The principles which he has always so ably asserted were demonstrated beyond any shade of doubt in the Russo-Japanese war. Just at this time when the question of naval construction and equipment is prominent among all the Great Powers, we are glad to welcome, through Mr. McFarland's introduction, the following article by Comdr. Worthington, showing accurately how the U. S. Naval Academy is training the officers of the present and future, and how well the "amalgamation" for which Mr. McFarland was one of the chief sponsors has worked out in practice.

Comdr. Worthington's article gives a clearer idea, we think, than has ever before been presented of the elements and proportions of the Annapolis training and its adequacy for preparing men fitted to uphold the naval ascendancy of their country.—THE EDITORS.

WHAT constitutes an efficient Navy? Not ships, guns and machinery alone or even chiefly, but thoroughly trained, zealous and efficient officers and men. The ships of Cervera's fleet in 1898 were considered by some good judges to be superior to those commanded by Sampson, yet they were utterly wiped out in a few hours. What are the vital elements of *personnel* efficiency? Good engineers, good gunners, and good seamen. These are the men we must have if the Nation is to derive full value for the millions that it has spent and is spending on the fleet.

It has been stated so often that it is becoming trite, but it is nevertheless absolutely true that a war-ship is a great floating machine, and obviously the men who can maintain its efficiency must be skilled in the knowledge and practice of handling machinery; in

other words they must be engineers. The progress in naval development has been such that apart from the medical and the accountant officers, all others spend most of their time in directing men whose chief work is with machinery of some kind. Even guns of small calibre are intricate mechanisms, and the great guns with their turrets are aggregations of machinery of a very powerful and complicated kind. The torpedoes and their ancillaries are likewise delicate and complicated machines. When we come to submarines, even the air for respiration may depend on machinery. These are all mentioned as showing how thoroughly the work which has always been the province of the deck officer has become engineering work. It must be obvious, therefore, how accurate was the statement of President Roosevelt (when Assistant Secretary of the Navy) in 1897 that "On the modern war vessel every officer has to be an engineer whether he wants to or not."

The supreme importance of skilled engineering to the efficiency of the fleet "in the day of battle and the week afterward" being thus established, it is naturally of great interest to know what effort is made at Annapolis, where American naval officers are educated, to give them suitable instruction in engineering. The article of my old friend Commander Worthington, which follows, gives a great deal of valuable information on this point, and in a shape which enables the whole course to be analyzed. In an article which appeared in this Magazine some years ago, I made the statement that Annapolis had for a long time been essentially an engineering school, and the tables of Commander Worthington's article show this in the strongest possible manner. It is of great importance to note his conclusion that the strictly technical courses are not so thorough, or rather so complete, as the corresponding ones in the technical schools of the United States. This is partly accounted for by the very low standard of admission as compared with that of the great technical schools, but I think we must also consider that a wider range of experience is demanded. We demand that the young naval officers shall have a fair knowledge of mechanical and electrical engineering, of ordnance and of seamanship, as well as some acquaintance with languages and international law.

It seems to me that Commander Worthington is exactly right in his idea that the course at Annapolis must be considered as elementary, to be supplemented by post-graduate training. It is desirable, of course, that the entrance standards should be raised so as to omit much of the work which properly belongs to the preparatory schools,

thus enabling more thorough work to be done in the technical courses; but there is another view to be considered also. The courses in the technical schools are based on the idea that every graduate will be a designer or constructor. This is not the case at Annapolis. The vast majority of the graduates will be occupied mainly in the executive work of handling and repairing machinery. As the number needed for designing and building is small, and as those with natural aptitude for this kind of work are relatively few, it seems proper that the course at Annapolis for all the midshipmen should be of such a nature as to fit them for the executive side of the work, when properly supplemented by actual experience at sea and at the yards, leaving the training for the other part to special schools or courses, as is now being worked out in a tentative way. This very point was considered by the Personnel Board of 1897, of which I was a member, and I believe it was largely due to my earnest efforts that the existing scheme of relying for designers on men of special aptitude was adopted, rather than that of having a separate corps of engineers for designing and navy-yard work, as was suggested by some other members.

It is possible that some naval officers may be inclined to think that such matters as naval education and training should be left to them to settle, and that discussion of the subject by civilians is an interference. Such a view, if held, would be exceedingly short-sighted. On the contrary, it is to the best interest of naval officers themselves as well of greatest importance to the efficiency of the fleet that there should be among all the people a strong and intelligent interest in naval affairs. It is only when the citizens of the country generally come to understand how much is required of their naval officers in the way of education and training that it will be realized how badly underpaid they are. If it is not realized that the care of valuable ships requires highly trained officers, there will be many (as there are now some men in Congress) who will think them overpaid. In matters relating to engineering, we must look to the technical press for forming public opinion, and, in my judgment, THE ENGINEERING MAGAZINE, is doing a real service to the Nation and to the Fleet by its sustained and intelligent efforts to secure the highest efficiency in the engineering side of our *personnel*.

THE UNITED STATES NAVAL ACADEMY AS AN ENGINEERING SCHOOL.

By Walter F. Worthington, Commander, U. S. N.

The editors are indebted to the courtesy of Prof. Philip R. Alger, U. S. N., Secretary and Treasurer of the U. S. Naval Institute, for access to the photographs from which the illustrations of Comdr. Worthington's article were made.

CADETS MEASURING THE PITCH OF A SCREW PROPELLER.

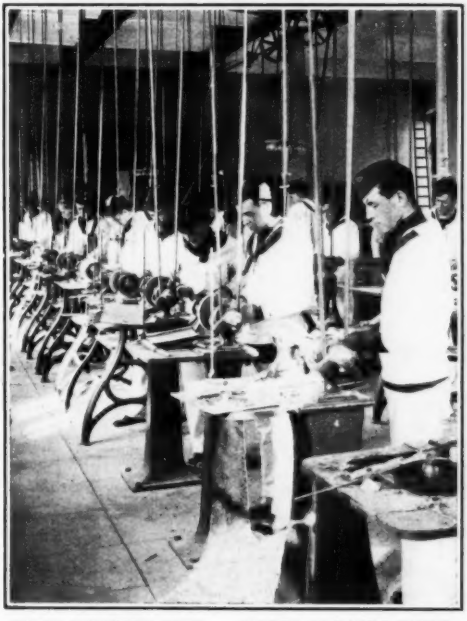
A FEW months before the present session of Congress, the Secretary of the Navy appointed a board of line officers on the active list, presided over by the Assistant Secretary, to examine into the requirements of the Navy Department and of the whole personnel of the United States Navy, and to report what changes, if any, should be made in existing laws.

The board reported just before Congress met, recommending many radical changes, but made no suggestion toward abandoning the amalgamation feature of the present organization, and the Secretary of the Navy approved the report of the board with the exception of a few minor details. Moreover, the President sent a special message to Congress on December 16, 1906, urging that a bill drawn up to put into effect the recommendation of the board be passed. It may therefore be assumed that no change of that kind will be made at least for years to come, if ever. Under the circumstances it will be of interest to review the course of engineering instruction given at the United States Naval Academy before and

after the passage of the present personnel bill, to see what place it had, and has, and what provision is made to secure for the Navy a sufficient number of officers with the requisite natural talent and special training to care for and work the costly machinery with which modern battleships are fitted. With this end in view the following tables have been compiled from the summaries given in the annual registers of the United States Naval Academy from 1895 to 1907.

This time divides itself naturally into three periods, viz.: 1895-99, when a small section of the first class of cadets was called the engineers' division, and was given additional instruction in steam engineering during the last year at the Academy; the second period, from 1899 to 1903, when the separate engineers' division was abolished, the course at the Academy remaining as before—four years; the third period, from 1903 to 1907, when, owing to the scarcity of officers in the Navy, the course at the Academy was reduced from 4 to 3½ years.

The instruction at the Academy during the academic year is shown in Table I, "studies," and Table II, "practical exercises." The instruction at the Academy during the summer months is shown in Table III., while Table IV shows the number and kind of ships on which were embarked that part of the corps of midshipmen (three classes) detailed for a cruise.



WOOD-WORKING SHOP. CADETS AT LATHE WORK.

It may be premised that with slight variations from time to time, each day, except Saturday, is divided into three study periods of two hours each, and one drill period of one and one-half hours, which latter is omitted on Wednesdays. On Saturdays there is one

Showing Number of "Study Periods" during the Day Devoted to all Subjects, by all Classes, throughout "Academic Year"

NAVAL STUDIES:	1895-96		1896-97		1897-98		1898-99		99-1900 Combined	1900-01	1901-02	1902-03	1903-04	1904-05	1905-06	1906-07
	Line	Engr's	Line	Engr's	Line	Engr's	Line	Engr's	Line Engr's							
Seamanship	4	2	4	2	4	2	4	1	4	6	6	6	4	5	5	6
Navigation	10	0	10	0	10	0	10	0	11	10	7	9	6	7	7	9
Summary	14	2	14	2	14	2	14	1	15	16	13	15	10	12	12	15
ENGINEERING STUDIES: Ordnance,	8	0	8	0	8	0	8	0	6	8	8	8	5	7	7	9
Steam Engineering	6	26	6	26	6	27	6	26¼	39	35	29	29	22	22	22	28
Naval Architecture	5	5	5	5	5	5	5	5	Combined with Engrng.	- -	- -	- -	- -	- -	- -	- -
Mechanical Drawing	8½	8½	8½	8½	8½	8½	8½	8½	Combined with Engrng.	- -	- -	- -	- -	- -	- -	- -
Applied Mechanics	12⅝	12⅝	12⅝	12⅝	12⅝	12⅝	12⅝	12⅝	Combined with Engrng. and Math.	- -	10	8	8	7	7	8
Physics and Chemistry	18	18	15	15	15	15	15	15	15	16	16	16	16	14	14	16
Mathematics	21	21	21	21	21	21	21	21	25	25	23	22	23	23	23	23
English and Law	20	20	20	18	20	18	20	18¼	17	12	11	13	11	11	11	13
Languages	17¼	17¼	17¼	17¼	17¼	17¼	17¼	17¼	14	15	17	15	17	16	16	15
Hygiene	½	½	½	½	½	½	½	½	1	1	1	1	0	0	0	1
Engineering Studies	116¾	128¾	113¾	123¼	113¾	124⅛	113⅛	124⅛	117	112	115	113	102	100	100	113
Naval & Engrng. Comb.	130¾	130¼	127¾	125¼	127⅛	126⅛	127⅛	125⅛	132	128	128	128	112	112	112	128
Ratio Engrng. Studies to Whole No. of Studies	from 1895-99 { Line 89.2 % Engr's. 98.6 %								1899-1903 - - 88.5 %				1903-07 - - 89.4 %			

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TABLE I. STUDIES, UNITED STATES NAVAL ACADEMY.

study period from 8 to 10, and one drill period from 10 to 12, the afternoon being a holiday. During the day one-half of each study period is devoted to study and one-half to recitations, so that the number of hours per week devoted to recitations in any subject would be found by dividing the number of study periods by two. The evenings each day except Saturday are devoted to study. Four weeks make the academic month and four months the academic term. Two terms make the academic year, at the end of which studies cease, the summer cruise and summer practical work begin, and continue to September 1, the month of September usually being a holiday, except for the midshipmen who entered the previous June.

It must be noted that at one time naval construction was combined with seamanship and later transferred to the marine engineering department; mechanical draughting was at first a separate department and later combined with marine engineering. Applied mechanics was for a time a separate department, then for two years (1899-1901) combined with marine engineering, then later separated again.

Taking a comprehensive view of the subject, it is to be observed that so far as studies are concerned, if the first three subjects, viz.: Seamanship, Navigation, and Ordnance, were omitted, all the remaining studies would be just what was necessary for any engineering school educating young men between the ages of 15 and 20. Moreover, the subject of ordnance is a special branch of mechanical engineering, and its study fits the student for other engineering work rather than for essentially nautical work. This being the case, the periods spent on seamanship and navigation are summed up separately from the periods spent on the other studies, and it is seen at a glance that as far as book work is concerned the Naval Academy has been principally an engineering school during the whole time under consideration. It may be added that the same conditions as exhibited in the year 1895 existed for some years prior to that date. From 1895 to 1899 Table I shows 89.2 per cent of time devoted to engineering studies in the case of the line cadets, and 98.6 per cent in the case of the engineer cadets. When the classes were combined the effect at first was evidently to cut down the percentage of time given to engineering studies, but this percentage was raised again and is now the same as it formerly was for the line cadets.

Much time might be gained for technical studies, if the hours assigned to mathematics and English were reduced by raising the requirements of the entrance examinations in these two subjects

Showing Total Number of Instructions Given in all Subjects, to all Classes, throughout Academic Year.

	1895-96		1896-97		1897-98		1898-99		'99-1900	1900-01	1901-02	1902-03	1903-04	1904-05	1905-06	1906-07
	Line	Engr's	Line	Engr's	Line	Engr's	Line	Engr's	Line & Engr's Combined							
Seamanship	180		180		315		303		218	196	125	125	95	83	76	76
Boats under Oars & Sails	42		42		78		78		60	73	37	37	42	68	52	52
Signals	9		9		36		36		39	40	10	10	9	10	10	10
Battery Drill	28		28		52		36		20	80	32	32	20	20	0	
Target, Great Guns	12		12		48		48		48	92	24	24	18	18	12	12
Target, Machine Guns	4		4		16		16		16	0	0	0	0	0	0	
Target, Small Arms,	17		17		68		68		55	54	12	12	18	20	33	33
Battle Drill	4		4		4		4		0	24	12	12	8	8	12	12
Clear Ship	0		0		0		0		0	4	12	12	16	8	12	12
Collision	0		0		0		0		0	0	12	12	0	0	0	
Practical Ordnance & Drill,	15		15		60		60		70	58	15	15	56	57	54	54
Artillery	20		20		60		80		80	80	10	10	16	32	24	24
Battalion Artillery	40		40		52		52		32	36	44	44	16	0	0	
Landing Party	8		8		16		16		0	0	0	0	3	3	4	4
School of Soldier	0		0		0		0		0							
School of Company	31		31		92		92		176	164	45	45	28	36	32	32
Battalion Infantry	48		48		36		36		32	44	44	44	44	44	36	36
Skirmish Drill	16		16		64		64		0							
Sword Exercise	45		45		180		180		159	156	40	40	33	33	33	33
Bayonet Exercise	0		0		0		0		0	3	3	3	3	3	2	2
Setting-up Drill	0		0		0		0		0	2	2	2	2	2	2	2
Deviation Compass	4		4		4		4		4	4	4	4	4	4	3	3
Great Gun Drill													10	10	22	22
Navigation	14		14		14		14		0	0	14	14	0	0	0	
*Steam Tactics	22	22	22	22	70	70	70	70	64	64	16	16	40	8	14	14
*Surveying	10		10		10		10		0	0	10	10	0	0	0	
*Steam Engineering	60	† 208	60	† 208	180	† 283	57	† 195	327	167	150	150	138	130	124	124
*Running Steam Launches	9	9	9	9	37	37	37	37	32							
*Electricity	15	15	15	15	55	55	60	60	49	38	10	10	10	10	10	10
*Chemistry	0	0	0		0		0		0							
*Turret Drill	0	0	0		0		0	0	0	18	7	7	4	5	5	5
*Torpedoes	4	0	4		16		16	0	19	15	5	5	5	15	15	15
*Gymnastics	17	17	17	17	76	76	76	76	76	68	30	30	15	14	15	15
*Dancing	18	18	18	18	36	36	36	36	36	34	18	18	19	20	16	16
TOTAL during Winter	632	289	632		1675		1549		1612	1514	743	743	672	661	618	618
Engrng. " "	155	289	155	289	480	557	362	474	603	404	246	246	231	202	199	199

*NOTE: Considered here as Engineering Practice since no change need be made in any of these Exercises, if the course was arranged for the Engineers Division only.

† NOTE: Extra Time for Engineering Division in Steam Engineering, obtained by excusing them from some of the Naval Drills.

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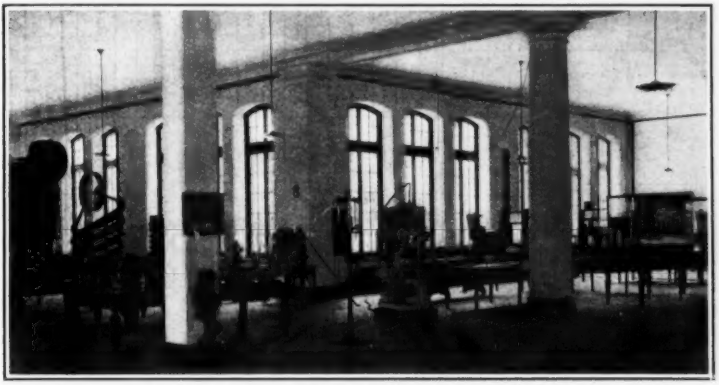
TABLE II. PRACTICAL EXERCISES DURING THE WINTER.

which are taught in the public schools of the country. The objection to doing this arises from the fact that the standard of the public schools is higher in some States than in others, and if the standard for admission to the Academy was raised, the effect would be to exclude young men from many of the States, who with plenty of natural talent would be deficient in education. In order that the Navy shall be a truly national one, it is highly desirable that both its officers and men should be recruited from every State of the Union.



MODEL ROOM, WEST SIDE OF CENTRAL WING.

The best course appears to be to give post-graduate instruction in engineering. This may be done by detailing graduates of the Naval Academy to private technical schools, or by assigning graduates to special technical work under the direction of an older officer. This latter method has been adopted by the Navy Department in recent years and appears to be the better plan. So far as my observation goes any defects in design of engineering work as found in the Navy do not come from lack of knowledge of mathematics or physics, but rather from lack of experience due largely to the fact that few ships have been built and opportunities for designing, building, and operating machinery have consequently been insufficient. With the knowledge of mathematics and physics possessed by the graduate of the Academy selected from the upper half of the class, he can readily take up any branch of engineering to which he may be assigned.

With regard to practical exercises (Table II and III) it is seen that much the larger part of the time is given to such as are essentially naval. To bring this out clearly, the order of exercises as given

Showing Total Number of Instructions Given in all Subjects, to all Classes, throughout Summer Months, at the School.

	1895-96		1896-97		1897-98		1898-99		'99-1900	1900-01	1901-02	1902-03	1903-04	1904-05	1905-06	1906-07
	Line	Engr's	Line	Engr's	Line	Engr's	Line	Engr's	Line & Engr's Combined							
Boats under Oars & Sails,	15		15		94		94		94	190	190	99¼	64	64	64	24
Signals,	5		5													
Battery Drill,	10		10													
School of Battery,	10		10													
Target, Machine Gun,	5		5													
Target, Small Arm,	10		10													
School of Soldier,	24		24													
Rigging Loft,	0		0		112		112		112							
Setting-up Drill,	0		0		112		112		112	171	171	0	48	48	48	60
Seamanship,	0		0						0	0	0	0	96	96	96	36
Ordnance (Drill),	0		0									142⅔	96	96	96	60
*Steam Tactics,	5	5	5	5												
*Steam Engineering,	59	118	0	0								190	64	64	64	48
*Running Steam Launches,	6	6	6	6												
*Gymnastics & Boxing,	0	0			94	94	94	94	94	95	95	95	48	48	48	60
*Swimming,	24	24	24	24	112	112	112	112	112	171	171	0	32	32	32	48
TOTAL during Summer	173		114		524		524		524	627	627	527⅓	448	448	448	336
TOTAL during Winter	692		653		1675		1549		1612	1514	743	743	672	661	618	618
TOTAL during Year	865		767		2199		2073		2136	2141	1370	1270⅔	1120	1109	1066	954
TOTAL Engrng. in Summer	94	153	35	35	206	206	206	206	206	266	266	285	144	144	144	156
TOTAL Engrng. in Winter	155	289	155	289	480	557	362	474	603	404	246	246	231	202	199	199
TOTAL Engrng. in Year	249	442	190	324	686	763	568	680	809	670	512	531	375	346	343	355
Whole 12 months-%	28.7	51.1	24.7	42.2	31.2	34.7	27.4	32.8	37.8	31.2	37.3	41.8	33.4	31.2	32.1	37.2
	Line 28.0 %								37.0 %				33.5 %			

*NOTE: Considered here as Engineering Practice since no change need be made in any of these Exercises, if the course was arranged for the Engineers Division only.

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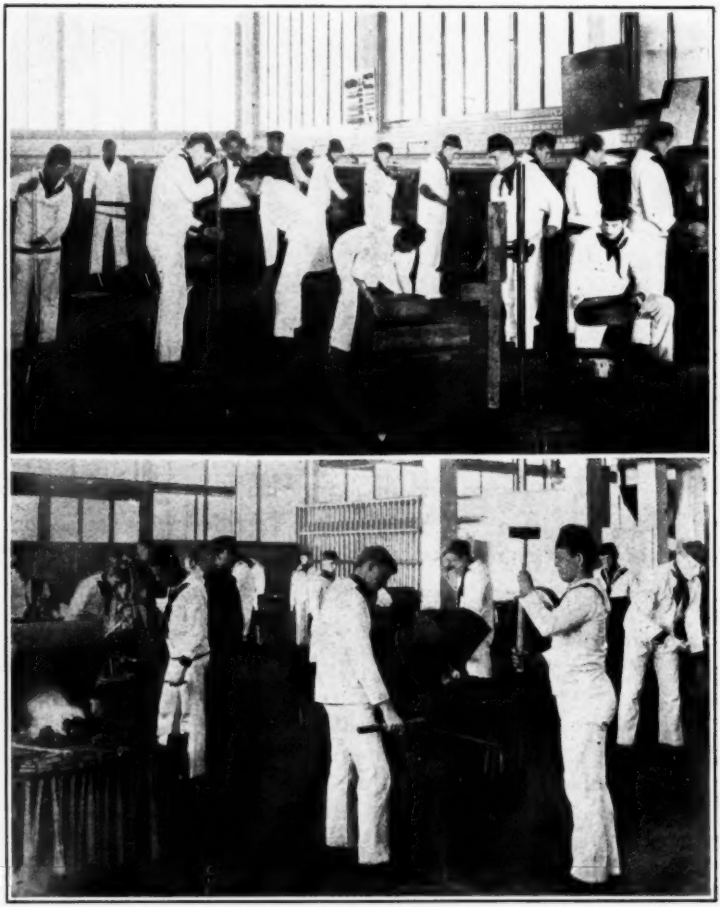
TABLE III. PRACTICAL EXERCISES DURING THE SUMMER.

AT WORK IN THE DRAUGHTING ROOM.

in the register is somewhat changed and the following items considered to be engineering practice are grouped together: Torpedoes, Steam, Steam Launches, Steam Tactics, Electricity, Turrets. The exercises of dancing and gymnastics are equally appropriate to either a naval or engineering school. At first glance it appears that an immense amount of time is devoted to these naval exercises. It must be remembered that during the academic year this time is at the latter part of the day, after 4 P. M., when some kind of physical exercise and recreation is necessary, and on Saturdays when students at other schools would be engaged in playing games. Also much of this kind of work is done during summer when little else could be done on account of the hot weather.

Examining the summary at the bottom of Table III we note that the percentage of time assigned to engineering exercises for the engineer division fell gradually from 51.1 per cent in 1895 to 32.8 per cent in 1898. Then when the engineer and line cadets were amalgamated the percentage rose to 37.8 per cent in 1899 and to 41.8 per cent in 1902, almost as high as it was for the engineers alone in 1896. In 1903, when the course of study at the Academy was reduced from 4 years to 3½ years, it is seen that the percentage of time assigned to engineering exercises dropped from 41.8 per cent to 33.4 per cent, but it has since gradually risen to 37.2 per cent, which is,



PART OF THE COURSES IN PRACTICAL SHOP WORK.

The upper view shows cadets moulding in sand in the iron and brass foundry. The lower view shows work at the forge.

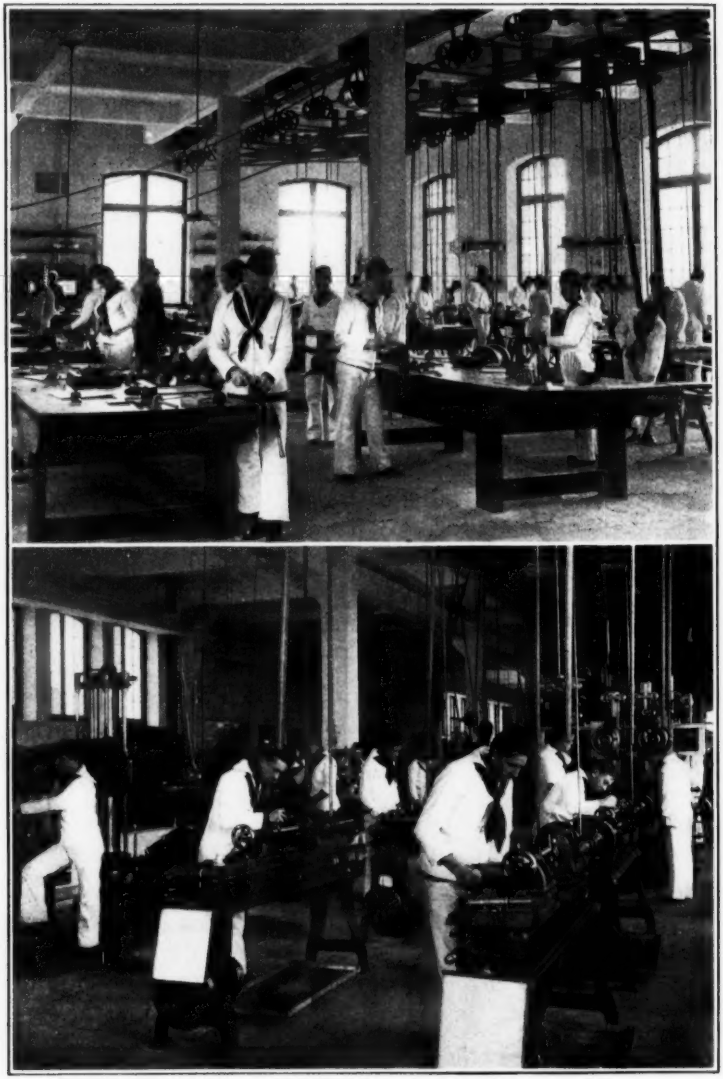
even under these adverse conditions, greater than it was for the engineers alone during the two years preceding the amalgamation.

The effect, then, of amalgamation at the Academy, with regard to studies, appears to have been to drop out the course of engineering previously given to a small portion of the first class, and to give to the whole class the course that was formerly given to the line cadets. The effect with regard to practical exercises was to omit the special

instruction of a few, but to increase the percentage of engineering instruction for the whole school from an average of 28 per cent prior to the amalgamation, to 37.0 per cent the next four years, and to 33.5 per cent when the course was reduced from 4 years at the school to 3½ years. Moreover, in the autumn of 1904 the new engineering building was completed and equipped with the most modern tools, appliances, and models, and the facilities for instruction were greatly

VIEWS IN THE MACHINE SHOP, SHOWING THE INDIVIDUAL AND GROUP ELECTRIC DRIVING.

The general view, above, shows the group-driving system and bench equipment. The lower best illustrates the individual driving of machine tools.



PRACTICAL SHOP EXERCISES.

Above, bench work in the wood-working shop; below, practical working with machine tools.

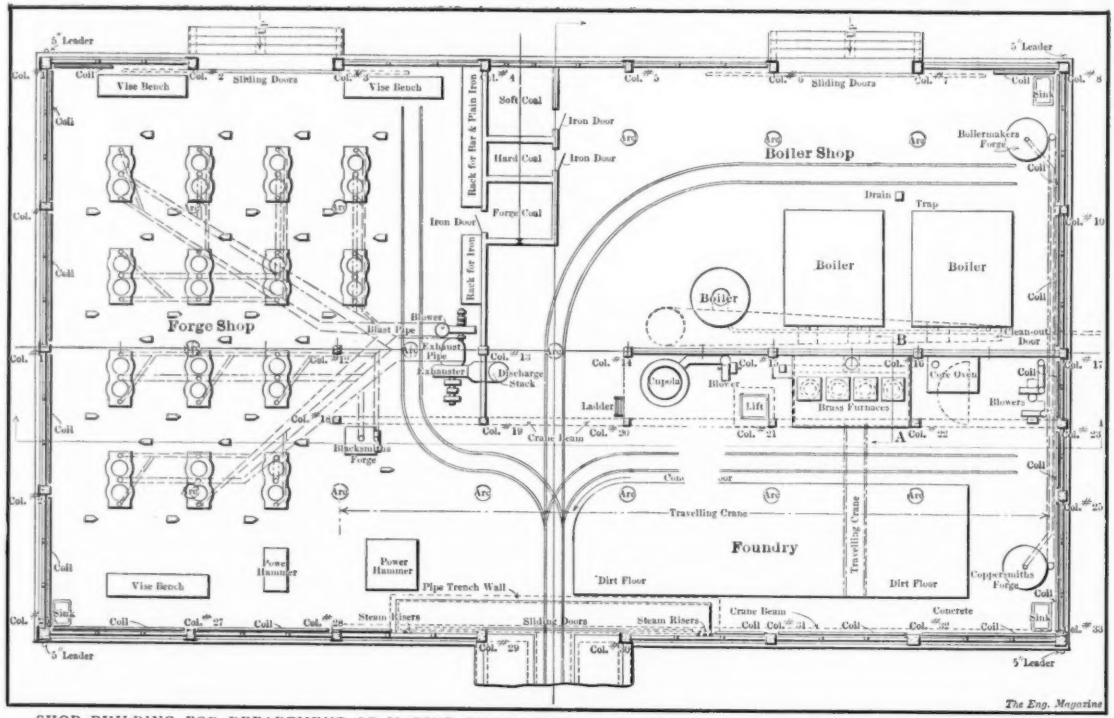
improved. Also, as seen by Table IV, at that date the coast squadron of battleships, cruisers, and destroyers, began to be utilized for the instruction of midshipmen, and it may be fairly concluded that the practical instruction on shipboard is now far better than it ever was before, for either midshipmen or engineers.

TABLE IV.

SHIPS USED FOR PRACTICAL INSTRUCTION OF MIDSHIPMEN ON SUMMER CRUISE, JUNE 10 TO SEPTEMBER 1.

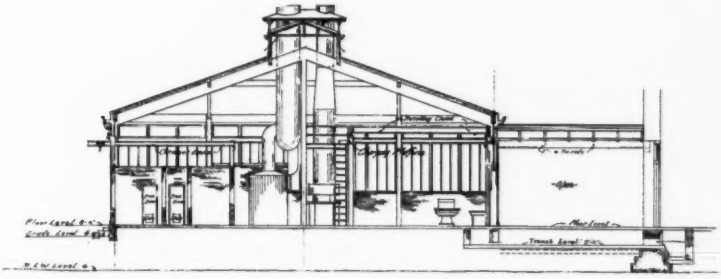
1895	1 Wooden Sailing Vessel, 1 Modern Steel Gunboat.
1896	1 Wooden Sailing Vessel, 1 Modern Steel Gunboat.
1897	1 Wooden Sailing Vessel, 1 Old Tug Boat.
1898	Instead of practice cruise about half of the midshipmen were detailed on vessels engaged in War with Spain.
1899	1 Wooden Sailing Vessel, 1 Modern Composite Gunboat.
1900	1 Sailing Gunboat, 1 Modern Steam Gunboat.
1901	1 Modern Battleship, 1st class, 1 Sailing Gunboat.
1902	1 Modern Battleship, 1st class, 1 Sailing Gunboat.
1903	1 Modern Battleship, 1st class, 1 Old Wooden Sailing Frigate with modern auxiliary steam power. 1 Sailing Gunboat with modern auxiliary steam power.
1904	1 Modern Battleship, 1st class, 1 Modern Battleship, 2d class, 3 Modern Monitors, 7 Torpedo Boat Destroyers, 1 Old Wooden Sailing Frigate, with modern auxiliary steam power, 1 Sailing Gunboat with modern auxiliary steam power.
1905	1 Modern Battleship, 2d class 3 Modern Monitors, 1 Old Monitor, 1 Cruiser, 2d class, 1 Cruiser, 3d class, 4 Torpedo Boat Destroyers, 1 Old Wooden Sailing Frigate with modern auxiliary steam power, 1 Sailing Gunboat with modern auxiliary steam power.
1906	1 Cruiser, 2d class, 3 Protected Cruisers, 3d class, 3 Modern Monitors, 1 Sailing Gunboat with modern auxiliary steam power.

Table IV shows that as the number of modern ships in the Navy has been increasing since 1895, the number available and used at the Academy has also increased, and is now all that could be desired. The ships take three out of the four classes—formerly, the 1st, 3d, and 4th class; latterly, the 1st, 2d, and 3d class—leaving the 4th class at the Academy for practical work. The present system makes it possible to give the 4th class practical exercises from their date of entry, May 20, to the beginning of the school term, October 1. The summer cruise lasts for about two and one-half months, and the work is eminently practical and calculated to interest the midshipmen in their studies and to emphasize the relative importance of the same, and to lead their thoughts towards those subjects which pertain es-



SHOP BUILDING FOR DEPARTMENT OF MARINE ENGINEERING AND NAVAL CONSTRUCTION. UNITED STATES NAVAL ACADEMY, ANNAPOLIS, MD. SCALE APPROXIMATELY 1: 235.

By courtesy of Ernest Flagg, Architect.



CROSS SECTION OF SHOP BUILDING, ANNAPOLIS.
By courtesy of Ernest Flagg, Architect.

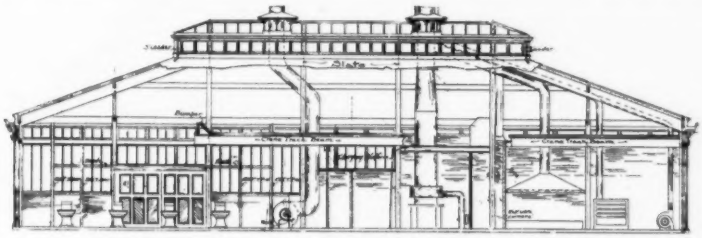
pecially to their profession. The instruction covers all the mechanism in the ship and is necessarily largely engineering work.

The foregoing tables and remarks explain as fully as can be done within the limits of a magazine article the state of engineering at the United States Naval Academy. Those who wish to go further into the subject can refer to the "Annual Register, United States Naval Academy," which explains in detail exactly what instruction is given under the various headings mentioned. From the same data different readers will naturally draw their own inferences. My own conclusions are as follows:—

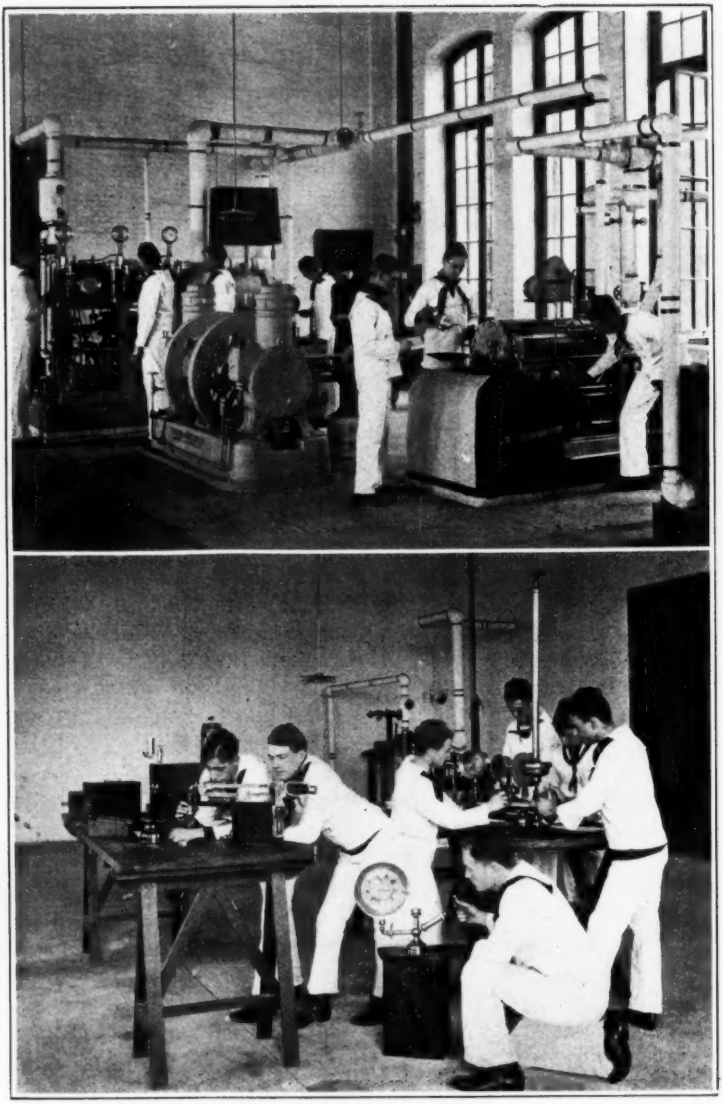
1.—The United States Naval Academy is today, and has been for the past twelve or fifteen years, a good school for elementary mechanical engineering, for students between the ages of 15 and 20 years.

2.—It does not provide as thorough a course in the technical branches of engineering as is to be found in the leading technical universities of the United States.

3.—Taking into consideration the number, variety, and interesting character of the practical exercises, the fact that every student is



LONGITUDINAL SECTION OF SHOP BUILDING, ANNAPOLIS.
By courtesy of Ernest Flagg, Architect.



IN THE ENGINEERING LABORATORY.

The upper view shows the cadets at work on experimental engine tests and tests of the ice machine. The lower illustrates the calibration of indicator springs and testing of steam gauges.

MODEL ROOM, EAST WING.

required to participate, and the further fact that every one of these exercises is under the direction and control of a responsible and competent officer, that any student found physically defective from any cause is dropped, it is highly probable that every member of a graduating class is better equipped physically for the battle of life than any class of a corresponding age from any other school in the country, except of course the Military Academy, where the conditions are quite similar. Considering the importance of a well rounded physical development to the engineer as compared to that required by those engaged in the more sedentary professions, such as the lawyers, doctors, ministers, professors, etc., one might well expect that the Academy graduate at the end of a term of years after graduation would rank high among engineers of his own age from other schools, no matter what branch of the work he might take up.

THE PLANNING AND CONSTRUCTION OF THE POWER PLANT.

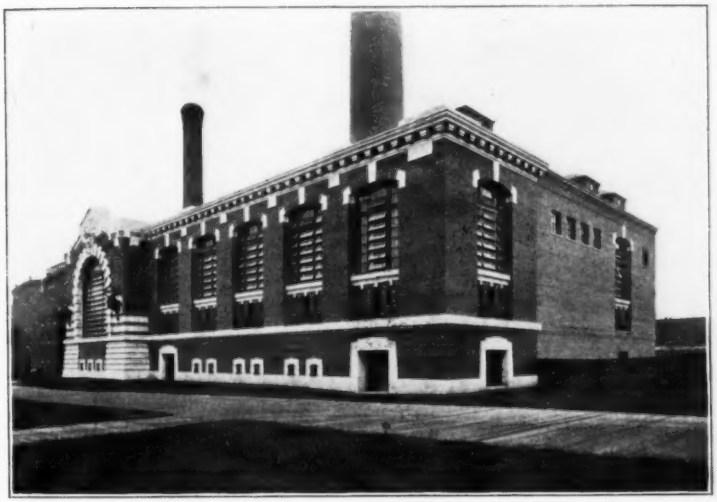
By A. E. Dixon.

VII. DESIGN AND ARRANGEMENT OF THE CENTRAL-STATION BUILDING.

Mr. Dixon's series began in September, 1906, and has taken up successively location, fuel storage, boilers and draft, water supply, main and auxiliary machinery, and gas producers and engines. With this issue his articles are brought to a close for the present.—THE EDITORS.

SOME time since, the editor of the Street Railway Journal aptly classified the prevailing type of power-plant architecture as that "of the shoe box crowned with a piece of stove pipe"; and while there are a few exceptions to this rule, it is to be regretted that in the attempt to save a few dollars one of the façades is usually entirely ruined by the type of coal-handling plant adopted. The majority of these plants are located on the water front and arranged to receive their fuel from boats, and from this fact the coal tower is the most conspicuous element—in some cases to such an extent that it entirely overpowers the main building and conveys the impression that there is a coal-handling plant with a power-house annex. While it is essential that there should be a coal-handling plant, it is at the same time possible to design a structure which will harmonize with the main building without in any way interfering with its usefulness; necessarily such a structure cannot be erected for the same cost as naked structural steel supporting a few corrugated-iron sheathed shanties; to offset this the expenses of upkeep on the structure would be reduced.

The design of the main building and of its framing depends upon the layout of the plant adopted, and this in turn hinges on the types of apparatus selected for the generation of steam and electricity. The "unit system" of design for the mechanical installation permits the same system to be used in the design of the steel frame for the superstructure, which preferably is of the self-supporting type. The outside walls and the division wall can be supported by the steel frame, if desired, but for structures of the (comparatively) moderate height required for power-house purposes it is better practice to design the walls to support themselves. A much better effect is also gained in those cases where the two sections of the building are of the same height, pavilions being used at the corners to break the monotonous



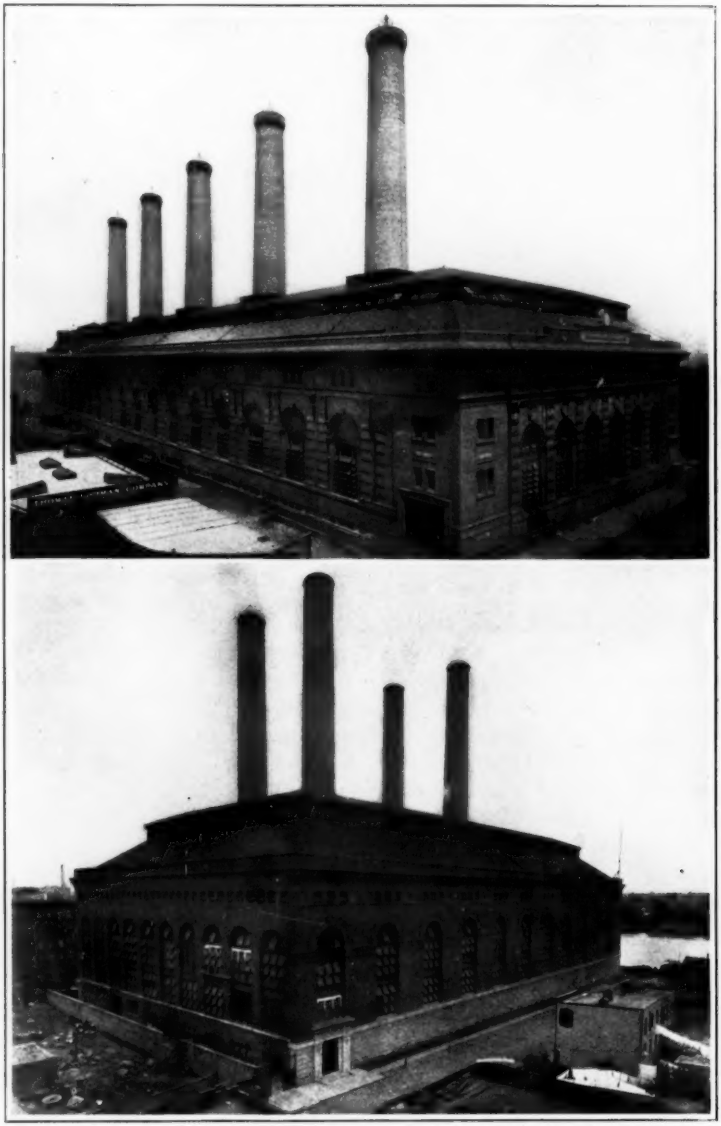
BOILER HOUSE, TURBINE STATION OF THE EDISON ELECTRIC ILLUMINATING CO., BOSTON.

By courtesy of J. E. Moultrop, M. E.

straight lines; if the building is of great length intermediate pavilions can be used; a small reveal at the pavilions is also of use for the purpose of emphasizing them. The lower portion of the wall can be designed to form a sort of a pediment with a terra-cotta water table, or this portion of the wall can be of a different material. Terra cotta also serves a useful purpose in forming a coping for the parapet and for the cornice, of if more desirable the wall can be corbelled out to form the cornice. With regard to material, a good quality of re-pressed brick can usually be obtained for a reasonable price and is in the long run less expensive than common brick, owing to the fact that it is not so porous. Perforated vitrified brick can be used for the backing, and have the advantage of being lighter and stronger than common clay brick.

The concrete building block has made its appearance as a wall material and has some good qualities; it is a new material and should be watched with interest. A few buildings have been erected with concrete walls made in forms built in place, and where the structure has a number of bays exactly alike the amount of form work is reduced to a minimum.

One of the uncompromising features of the power house is its chimneys. When these arise from the center of a peaked roof, as in



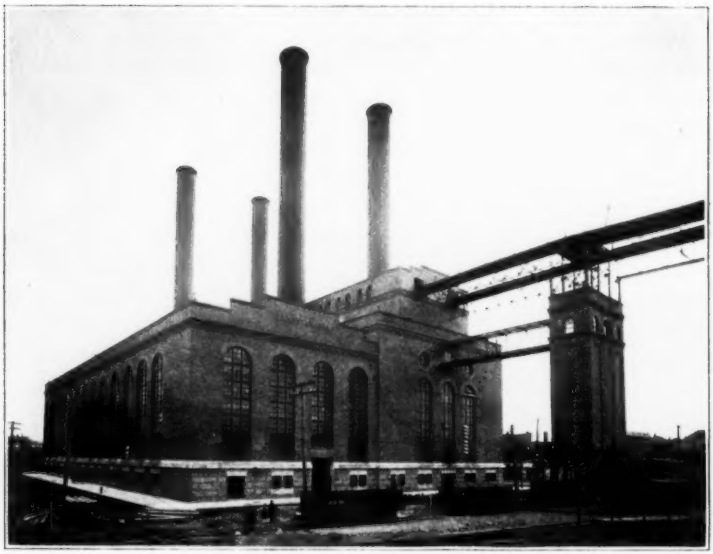
TWO POWER HOUSES OF THE INTERBOROUGH RAPID TRANSIT CO., NEW YORK CITY.

The upper view shows the 11th Avenue façade of the 50th St. power house; the lower, the 74th St. façade of the 74th St. power house. Photographs by courtesy of E. P. Bryan, president.

the case of those of the West 59th Street plant of the Interborough Rapid Transit Co., the building appears to act as a pedestal for them without it being dwarfed. The architectural effect is not attained, however, when the chimneys are located close to the walls of the building or when a number of them are used. In power-house design, however, it is the results attained from the completed machine which must be considered; and while a good architectural effect is to be desired, the efficiency of the plant cannot be sacrificed to gain it.

For the interior finish of the walls a light colored pressed brick has many advantages, and such a finish, unlike a coat of paint, never requires renewal. If desired the monotony of the surface can be broken by panels outlined by brick of a contrasting color. An enamelled tile wainscote, four or five feet in height, is advantageous at each floor for the reason that its surface is easy to keep clean and it cannot absorb grease from the overalls of workmen who will from time to time lean up against it. Pilasters can be used to conceal the building columns, and a cornice constructed just below the crane girders which will greatly improve the appearance of the room. The crane girders and roof trusses can be enclosed with wire lathing and plastered. The boiler room in many plants appears raw and unfinished as compared with the operating room, often giving the impression that so much had been expended upon other portions of the building that it had been found necessary to economize on this part, to which comparatively few visitors are admitted.

Daylight is the cheapest form of illumination and the more of it that can be admitted the better; for this reason the main windows should be as large as possible, both in height and width. Where exposed at any time to the direct rays of the sun, rough surface or translucent glass should be used, and wire glass owing to its advantages as a fire retardent should be used in all cases where the structure is exposed to danger from surrounding buildings; in any case wire glass is preferable to plain glass. Metal window sashes and frames are also necessary for fire protection, and suitable operating devices should be employed for their opening and closing. Some of the mechanical arrangements used for this purpose become chronically out of order in a short time after their installation, and while a device of this character is but a small item in the entire structure, it may be the cause of windows being permanently left open and an excessive amount of steam being used for heating purpose, in preference to the closing of such sashes as are not needed for ventilating purposes. The cast-iron window frames, which are often



GENERAL VIEW OF POWER STATION AND ASH TOWER, LONG ISLAND CITY—PLANT OF THE P. N. Y. & L. I. RAILWAY.

By courtesy of George Gibbs, Engineer E. E.

used in power plants, require careful fitting to insure tightness, and in many cases it is necessary to use a rubber gasket to get this result. In some windows, particularly those in the locker rooms, offices, etc., it may be necessary to use a double sash in order to avoid draughts and the trouble occasioned by rain or snow driving in around the movable sashes in metal-framed windows.

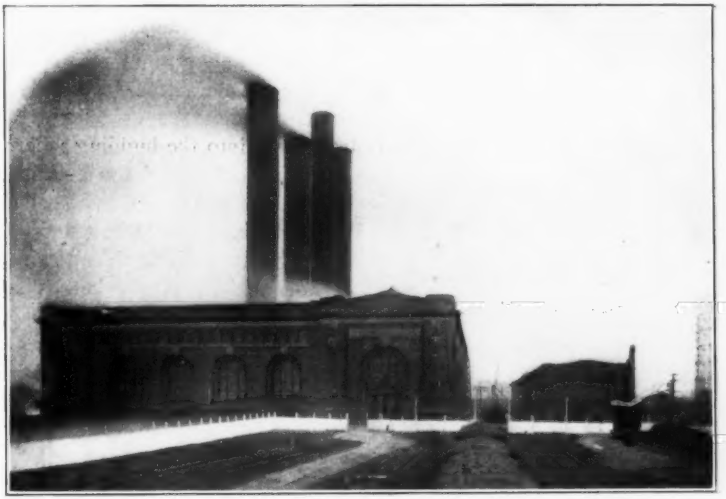
Skylights furnish a very desirable means of supplying light, particularly for the operating floor, and can be placed in every other bay, or the entire roof can be glazed. They must be so designed that the water of condensation can be taken care of by gutters and drains, for the drip might ruin an expensive electrical generator.

For the purposes of ventilation a monitor is usually provided over both the operating and boiler rooms; over the operating room glazed sashes opening on pivots are usually provided, while over the boiler room this structure houses the machinery for distributing coal to the bunkers and in some cases only alternate bays are glazed, the others containing fixed louvres.

Spanish roll tile roofing has been used on some prominent plants set on book tile carried by "T" irons supported by the purlins. Re-

inforced-concrete slabs are just as efficient as the book tile, and with this construction a coat of mortar is not required on the lower surface to secure a uniform finish. Standing-seam copper roofing is very durable and soon acquires a uniform coating of oxide; this roof is not as expensive as the tile finish but is probably just as durable.

In the design of platforms and walkways there are often fixed limits to be considered, owing to such matters being left out of the reckoning until the last minute, with the result that there are many places with very close clearances. The boiler-room walks must be so arranged that all of the valves can be reached without the necessity of walking on the pipes. Light iron gratings carried by channel-iron stringers make a good structure, the top of the grating being preferably below the top of the channel, which thus forms a sort of a curb to prevent things being kicked over the edge accidentally. This curb should be used around the edges of all machinery platforms and galleries for the same reason, as a bolt or a wrench disappearing over the edge at an inopportune time or place may cause serious damage. It is also advisable to provide curbs at stairway hatches and the edge of galleries forming parts of the building in order to prevent wash water from the floors going over the edge; these latter curbs can be arranged for in the design of the steel frame of the building.



FISK STREET POWER STATION OF THE COMMONWEALTH ELECTRIC CO., CHICAGO, ILL.

By courtesy of John F. Gilchrist, assistant to the president.

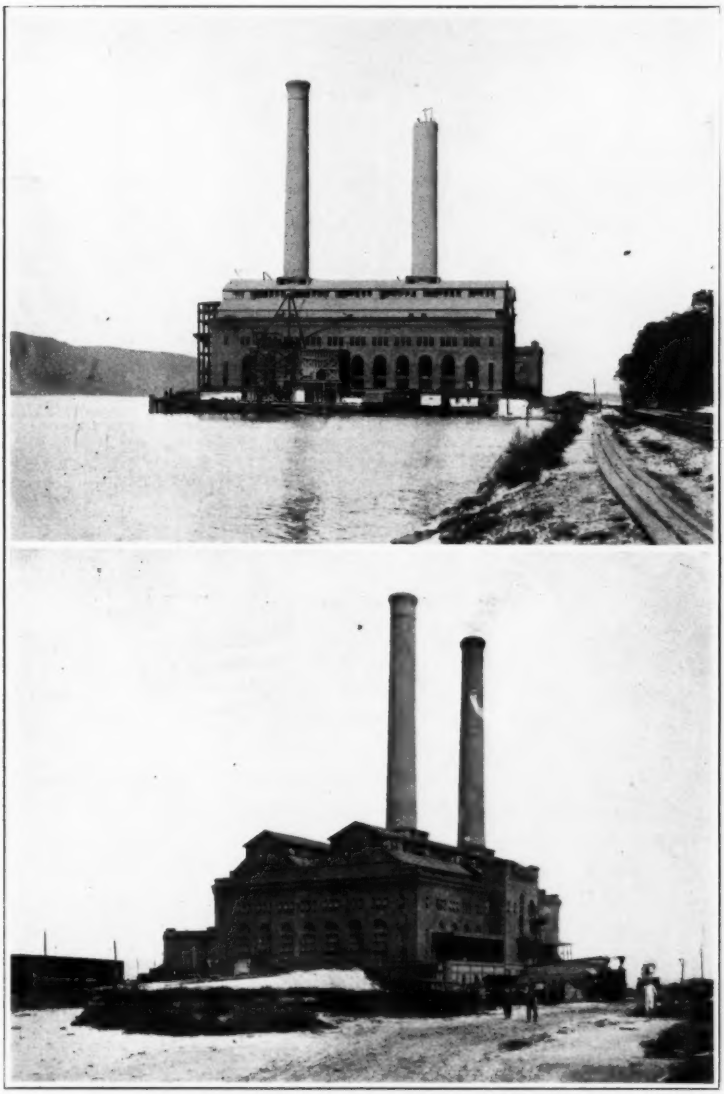
Concrete slabs and arches have to a large extent replaced the earlier floor construction of porous or hard-clay hollow tile, which in turn had superseded the brick arch. The floor finish can be colored so that the drippings of oil will not be conspicuous and a smooth hard surface is desirable. The sanitary curve should be used at all re-entrant corners, and all pipes passing through the floor should be surrounded by suitable thimbles of cast iron to protect their covering from wash water. Drainage slopes should also be arranged with floor drains so that as far as possible water will run off.

The main passageways of the building and the stairs should not be narrower than five feet, a greater width being used where possible. The stairs should be as straight as possible, for the reason that it is often necessary to carry pipes or other long pieces from place to place and this is a matter of difficulty with narrow or crooked passages. Ladders should be eighteen inches wide with the rungs one foot apart. The stairs to galleries on the machines should be from two feet to two feet six inches wide. In the proportioning of the ratio of riser to tread in all stairways the best results will be attained by the following formula: tread + twice the riser = 24 or 25 inches. Any intermediate figure between 24 and 25 which satisfies the equation gives good results. Slate stair treads are more durable than marble, but are not as handsome; the risers can be of cast iron and the stringers may be of either iron or steel. Cast-iron treads with a diamond-pattern surface are generally used for the unimportant stairs and those to the machine galleries and the risers are omitted.

The main doorways to the boiler and operating room should be of sufficient size to admit running railroad cars into the building where they can be unloaded by the crane; and the floor of the building should be designed to permit this. The main entrance doors should open into a small lobby or vestibule and facilities should be provided for an attendant at this point to receive visitors. The elevator and stairway leading to the office and visitors' gallery should be at this point also.

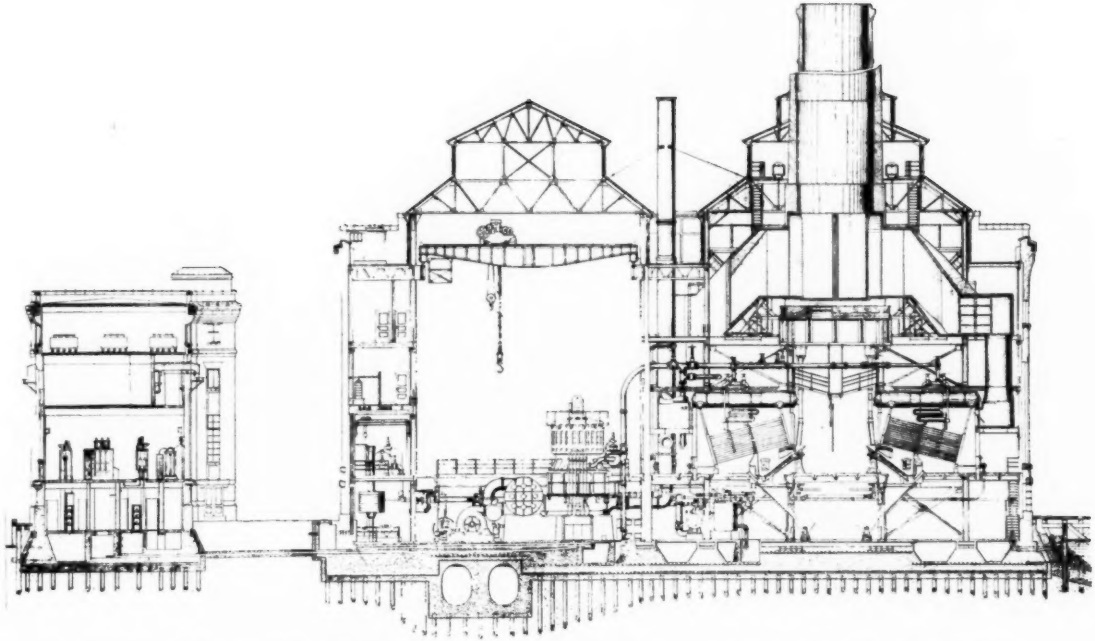
In the Long Island City power house of the Pennsylvania, New York and Long Island R. R. Company an elevator has been installed in the boiler room (with a pass-key control) reaching the top of the coal bunker; in most plants this point can only be reached by steep ladder-like stairways, which must be climbed a number of times a day on those occasions when the heating of the coal must be watched in order to prevent a bunker fire getting started.

In the question of small conveniences many plants are lacking, the lockers provided for the employees often being so small that it is



TWO GREAT POWER HOUSES OF THE ELECTRIFICATION SYSTEM OF THE NEW YORK CENTRAL RAILWAY.

The Yonkers station above, the Port Morris below. Both taken during construction. By courtesy of E. B. Katte.



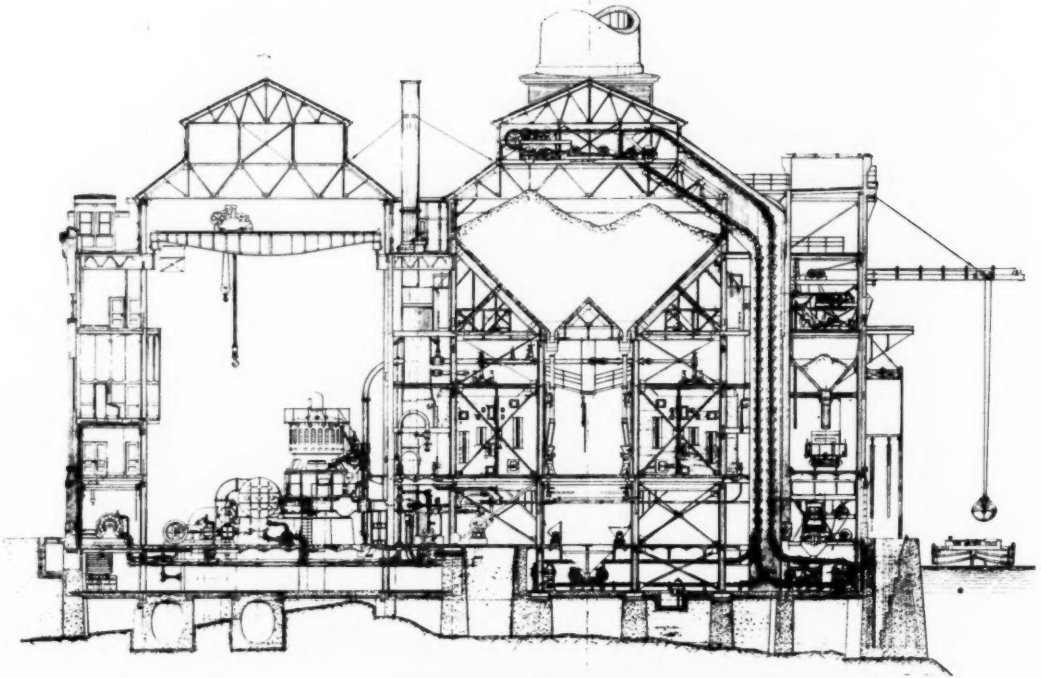
THE YONKERS POWER STATION, ELECTRIC-TRACTION SYSTEM OF THE N. Y. C. & H. R. R. R. NEW YORK DISTRICT.
By courtesy of E. B. Katte.

impossible to hang up a winter overcoat in them and a suit of clothes. The better class of employees like to make a complete change before going home and suitable accommodations for this purpose are a good investment. In many cases the locker rooms are so small that there is hardly any room in the passages and the men have to change in relays and are more or less in one another's way. The best plan gives each man two lockers, one for his working, the other for his street clothes, permitting him to get out of his working clothes and use the wash room before putting on his street clothes; and with this arrangement his street clothes do not get soiled by contact with the working clothes.

In the fitting up of the wash rooms and toilets marble is often used; an equally good effect can be gained by white enamelled slate or metal. Necessarily the fittings should be of first-class quality as the cheaper grades of plumbing give more or less trouble; both shower and tub baths should be provided and other facilities sufficient to accommodate the usual force employed.

With regard to the steel frame for the building, there is comparatively little to say; it should be designed according to the best practice in structural lines; the sections should be open ones, accessible for repairs and painting. Box or closed sections should not be permitted. The bracing, as far as possible, particularly in the boiler-room basement, should be portal bracing; where cross or "X" bracing cannot be avoided portal-braced panels should be introduced at intervals to provide passage ways. As a general rule "X" bracing should not be permitted except in locations where it will be encased in a partition. In many steel structures the columns rest on and are bolted to a grill supported by the foundation; in power houses the columns should be secured to the foundations by suitable anchor bolts.

The foundation is the most important portion of the power plant, and where rock or other solid bottom can be reached in a reasonable distance the foundations should be carried down to it. In most cases these plants are located on made or filled land; isolated piers in such cases are liable to unequal settlement; in addition there is always the uncertainty in regard to future development which may make necessary radical changes in the distribution of the loads; for this reason the mat foundation which insures equal settlement and permits the loads to be shifted around as may be desired is the one most suitable for a power plant. In this latter method the area of the site is filled with piles at practically uniform spacing, which are then capped with a monolithic mass of concrete. Timber piles have been exclusively used for heavy loads, until lately the concrete pile has been employed in some cases. Where they are always wet and protected from the



THE PORT MORRIS POWER STATION, ELECTRIC-TRACTION SYSTEM N. Y. C. & H. R. R. R., NEW YORK DISTRICT.
By courtesy of E. B. Katte.

teredo timber piles are very durable. In some cases the ground-water line fluctuates between wide limits, and in such cases timber will rot out very rapidly and cause trouble; for this reason considerable knowledge of local conditions should be acquired before the point of cut off is determined; in such locations the concrete pile will probably reduce the cost of the foundation required.

In the dark ages it was considered impossible to set a machine on a rigid foundation, and heavy timbers were often used to act as cushions; later someone found the machine worked better when the timbers were omitted. Another relic is the use of cap stones between the foundation and the machine, presumably to act as a bearing plate; the base of the machine furnishes sufficient bearing surface to make such stonework unnecessary, and it is merely a holdover from the time when such foundations were laid up in rubble masonry. Stone foundations were succeeded by those of brick laid up in cement and concrete has now become the usual material for foundations. Concrete can be given a very smooth surface, and when the corners are well rounded and a slight batter given to the sides it makes a very good looking foundation; if care is taken in the construction it is entirely possible to prevent the formation of the fine surface cracks.

The first step in the design of the power plant is the determination of the load curve, which for a new project involves much study of local conditions. For a plant to supply power for a railroad or tramway, time speed curves must be computed on a schedule to suit the case and an allowance must be made for the amount of current required to heat and light the cars; as every curve and grade has its effect upon the result a great deal of computing is required to determine the curve. For plants having only a light and power load, the number of customers and their requirements are secured by the preliminary canvass and the public-lighting requirements form the basis from which the load curve is arrived at; for some cases a combination of both methods will be used. The transmission and other conversion losses are of course added to the net requirements, as well as an increment to cover the probable increase in service for a term of years. A small plant does not involve and would not be justified in going as deeply into this matter as is necessary for large plants. Where an extension is to be made to an existing plant, or to centralize the generating system of a corporation having a number of small out-of-date plants, the existing load curves are known. The increment of growth usually made is supposed to be sufficient to cover the probable increase for five years or so, and in many cases it works

out so that the plant is loaded very nearly to its capacity when completed and is over-loaded long before it should be according to theory.

From the load curve is determined the capacity of the plant and the proper size to be adopted for its units. The layout or arrangement of the plant depends upon many considerations; the generators and type of prime mover, the size of boilers, the auxiliary machinery, the site selected, and the location of the tracks or waterways by which fuel is to be received, etc.

A favored layout is the unit system, by which, in effect, the plant consists of a number of separate plants with uniform equipment erected side by side; this system has many advantages and a few disadvantages and has been adopted in a number of prominent generating stations. In some few cases the building and sub-foundations have been completed for one or two units similar to those used in the primary installation; this plan, while it permits of the extension of the plant in record time, practically ties the operating company up to a particular design and make of machinery; later developments in the art may prove such a preliminary an expensive mistake. In the unit system the steam piping is usually so arranged that the adjoining units are cross connected and each can be operated with the boilers normally assigned to the other unit; on the condenser end each unit is independent, and the question arises if such an arrangement is the best that can be devised, particularly with the large units installed in many modern plants, and with steam turbines. In the endeavor to get the condenser as close as possible to the low-pressure end of the machine no means have been provided to cut the condenser off when running free-exhaust, and in some cases the exhaust steam must pass through the condenser to reach the atmospheric exhaust pipe. This last arrangement makes it necessary to shut down the main generating unit whenever any condenser repairs have to be made.

The high vacuum required by steam-turbine plants can be obtained as well with one type of condenser as with another, provided the air and circulating pumps as well as the condenser are designed for such work. It is desirable that the number of joints in the vacuum system should be as few as possible, and for this reason cut-off valves between the condenser and turbine are in most cases omitted, making the condenser practically an integral portion of the unit. Individual surface condensers have been used in turbine plants in order to reduce the water bill and the saving possible in this item justifies a very large investment in condensing facilities. Central surface-condensing plant has not been used to any extent, though central barometric

condensers have proved successful. There might be advantages in inter-connecting surface condensers and dry vacuum pumps as these portions of the condensing equipment often give some trouble; the advisability of this added complication would depend upon its value as a preventive of shut downs, and much would depend upon lcoal conditions.

COMPARISON OF THE FLOOR AREA AND VOLUME OF BUILDING OCCUPIED BY SOME RECENT POWER PLANTS.

Name of Plant.	Sq. ft. per k. w.	Cu. ft. per k. w.	Prime Mover.	No. of floors of boilers, two rows per floor.
Long Island City, N. Y.,	1.36	119.0	Parsons Turbine	2
Port Morris, N. Y.,	1.32	102.3	Curtis "	1
Manhattan, N. Y.,	2.06	200.0	Reciprocating Engine	2
Rapid Transit, N. Y.,	2.32	250.0	" "	1
Chelsea, London,	1.36	138.0	Parsons Turbine	2
Metropolitan, N. Y.,	1.27	170.0	Reciprocating Engine	3
Kingsbridge, N. Y.,	1.88	134.0	" "	2
Waterside, Old, N. Y.,	0.96	112.0	" "	2
Waterside, New, N. Y.,	0.80	108.0	Turbine	2
Boston Edison Co., Mass.,	2.45	146.0	Curtis Turbine	1
Fisk St., Chicago, Ill.,	2.40	139.0	" "	1
Bow Plant, London,	2.95	237.0	Reciprocating Engine	1

The arrangement of the various machines should be such that the amount of piping required will be as small as possible and the runs will be direct. The machines must have sufficient room around them to permit access to all points, and if possible, this passage should be five feet wide. Sufficient space must also be given to permit of the large machines being taken down and the parts being placed on the floor and the floor loads should be proportioned by the heaviest concentration of loading liable to occur.

In many cases the dimensions of the site are fixed by circumstances; for instance, in cities by the street lines; and it is necessary to utilize the area available to the best advantage. For these reasons it may not be possible to secure the most desirable arrangement of the equipment. The cost of the building and of the real estate also have a bearing on this question, and the endeavor should be made to secure the best results for the amount expended for this purpose. The differing advantages and disadvantages of a number of alternative arrangements must be considered; various types of machinery for the several purposes and their layout and the methods of piping necessary for connecting them up; all of these questions affect the general result and cannot be decided except by the result of much study, guided by past experience.

PRESENT PRACTICE IN THE USE OF SUPERHEATED STEAM.

By Reginald Pelham Bolton.

Mr. Bolton's discussion will comprise three articles, of which the first is here presented and the others will follow in immediate sequence. He is in close touch with his subject, having just finished the work on this part of one of the latest and largest American power-installations. He brings out very clearly the influence and limitations of superheat, its relations to other matters of steam practice, the practical changes it introduces into the installation of the steam system, and the best tried appliances and methods for meeting the new conditions. An index to all books and leading articles on the subject will be appended.

Mr. Bolton brings out collaterally the point that under the competition of the gas producer and engine, "the steam engine and boiler combinations have been forced to a second place in the record for economic production of power," and that this is in part because the definite and concentrated study of economy which has been lavished on the steam cylinder, has been withheld from the other end of the cycle—the fuel-draft and furnace-flue elements. Developing this suggestion, Mr. Bolton's series will be immediately supplemented with an equally important and suggestive treatment of fuel combustion in the boiler furnace, by Wm. D. Ennis.—THE EDITORS.

I.

IN the interesting historical paper on this subject, read in 1896 before the American Society of Mechanical Engineers, the facile pen guided by the ripe experience of the lamented Thurston laid before the engineering world the then existing state of the use of superheated steam, with an historical review of the successive steps which up to that period had led to its development and limited utilization. He summarized the conditions then existing in the United States by saying, that "practically nothing is being done on this side, and our own people, as a rule, have no experience in the practical use of superheated steam." He added that the scientific aspect of the subject had in Europe attracted more attention, and its utilization had there become much more general.

Ten years have passed since those weighty words were written, and it has fallen to my lot, at the request of the editors of THE ENGINEERING MAGAZINE, to point out another mile-stone on this line of progress, by a statement of the present condition of this matter in American engineering practice.

Though it is true that, at the time at which Robert Thurston wrote, the subject of superheat, or *ad-heat,* as he so neatly described it, was occupying little attention among engineers, he reminded us of

the fact that in its early stages of development, American inventiveness first reduced the system to any practically successful purpose. While the subject was known as early as 1828, when Gregor, a Cornish engineer, built flues around the steam pipes and cylinder of his pumping engine at the Bonner Downs Mine, raising thereby the duty of his machinery more than 50 per cent; and while this was followed by methods, adopted chiefly in France, for ad-heating the steam in somewhat similar manner, it was not until 1855 that a German, Hirn, developed the real system, and its first practical utilization was due, as has been said, to Wethered, an American engineer, at about the same period. The Stevens, in the construction of the boilers of their river and ferry boats in the vicinity of New York, had even earlier adopted a method of taking the steam supply from an annular space through which the smoke flue passed—a virtual superheater; and this may be considered the first, if rather crude, utilization of the system of adding heat to the steam after its formation at the working pressure.

No less than eighty years have elapsed since the earliest described conception of the subject, in the patent application of Becker, filed in the year 1827; and it seems, therefore, appropriate at this period to review more particularly the work accomplished in the past decade rather than to devote study to those elements which have contributed to delay, for so long a period, the general adoption of so apparently simple a device, and one which points so clearly in the direction of that economy of materials and energy, towards the accomplishment of which the efforts of engineers are (and properly so) generally directed.

Into the physical laws governing the addition of heat to steam vapor, or gas, it would be superfluous here to enter. That heat may be, and is, readily added to steam of a given pressure and corresponding temperature, is now common knowledge, as is the practical fact that steam vapor, with such added heat, becomes more nearly a true gas, less charged with contained moisture, and in such condition parts less rapidly with its heat by conductivity, and yet, by reason of its higher temperature compared with its surroundings, may relatively dissipate more heat than when in a condition of saturation.

The investigations as to the heat absorption of superheated steam, conducted by Grindley and Battelli, led to the theory that, in addition to the latent heat of steam and the heat required for the actual amount of superheat, there might be an additional latent heat absorbed at the point of converting the vapor into a true gas. This assumed

quantity has been termed "the heat of gasification," and the theory of its existence is still somewhat prevalent. Progressive tests made by Griessmann, however, discredit this theory, and indicate that the properties of dry steam are continuous from the saturation point to a truly gaseous condition.

Specific Heat.

Considerable study has been devoted during the past ten years to the ascertainment of the specific heat of superheated steam, a matter of basic importance in any investigations or computations concerning this subject. Not content with Regnault's value of 0.48 at atmospheric pressure, various observers commenced experiments of this nature, led about six years ago by Mr. J. H. Grindley, followed by Griessmann; their observations indicating the interesting result of a regular variation of specific heat according to pressure. Regnault laid down, as the mean result of three experiments, a uniform value of 0.48, which, though so limited and empirical, was until about six years ago accepted and generally used. J. McFarlane Gray, in 1889, pointed out, from a mathematical point of view, that the figures of Regnault were too limited, and Grindley, in 1900, reported experiments which indicated that the specific heat was a quantity dependent on pressures and temperatures. His work in this line was followed by Griessmann's more exact experiments, reported in 1903, which determined the foregoing view—that the specific heat varied with pressure and with temperature; and he established a series of figures, given below, which were generally confirmed by the investigations of Prof. C. R. Jones in the same direction.

Specific Heat Increase with Pressure and Temperature.

Pressure Absolute.	Pressures above Atmosphere per Square Inch.	Temperature of Superheated Steam.	Specific Heat.
14.22	0.48 lb. below	284.4	.513
21.33	6.63 lb.	288.4	.524
28.44	13.74 lb.	292	.534
35.55	20.85 lb.	295.6	.541
42.66	27.96 lb.	299.1	.548
49.77	35.07 lb.	305	.561
56.88	42.18 lb.	309.6	.575
63.99	49.29 lb.	314.4	.585
71.10	56.4 lb.	318.7	.596
78.21	63.51 lb.	323.6	.6
85.32	70.62 lb.	326.5	.6

This study was further developed by Lorenz, who found another feature, namely, that the specific heat diminished as the temperature increased, *when the pressure remained constant,* and so established

the now accepted fact that specific heat increases with increasing pressure and stable temperature, but diminishes with increasing temperature and stable pressure, as shown by the following:

Steam Pressure.	Temperature.	Specific Heat.
12.8 lb. per sq. in.	405.6	.531
12.2 lb. per sq. in.	561.2	.492
82.3 lb. per sq. in.	405.6	.622
82.3 lb. per sq. in.	534.7	.568
113 lb. per sq. in.	503.6	.64
113.1 lb. per sq. in.	596.8	.57

These two elemental facts seem to be now well established; the further experiments, with more precise methods, of Linde and Knoblauch have merely extended the principle and established a closer exactitude, as have the methods adopted for the same purpose by Holborn and Henning, in 1905.

The most recent work has been appropriately done at the laboratories of Sibley College, under the direction of Professor R. A. Carpenter, by electrical methods conducted by Professor C. C. Thomas and Mr. Burgoon; and these seem so far to indicate the interesting development that specific heat may be shown not to increase proportionally to increase of pressure to an indefinite extent, but that there may exist some modifications as higher pressures are reached. The final results are looked forward to with interest, and are promised to be presented ere long to the American Society of Mechanical Engineers.

Along this line the experiments have been conducted with much higher pressures, extending up to 600 lb. per square inch. The results of such experiments, by Professor Callender and Mr. Burgoon are plotted on page 278, Transactions of the American Society of Mechanical Engineers, 1906, Vol. 28, No. 2, and very well illustrate the features referred to.

FIXED SUPERHEAT, 300 DEGREES F., AND VARIABLE PRESSURE.

Pressure.	Specific Heat.	
	Callender.	Burgoon.
100 lb. absolute.	.523	.517
200 lb. absolute.	.555	.552
300 lb. absolute.	.582	.59
400 lb. absolute.	...	.623
500 lb. absolute.	...	.66
600 lb. absolute.	...	.7

VARIABLE SUPERHEAT; FIXED PRESSURE, 200 LB. ABSOLUTE.

Superheat.	Burgoon. Specific Heat.
100 degrees F.	.597
200 degrees F.	.575
300 degrees F.	.552
400 degrees F.	.53

Moisture.

To the interesting subject of the temperatures and pressures under which moisture may still be present in superheated steam, Professor Richter has devoted some study, and this physical condition offers an opportunity for further investigation on the part of scientists.

Early Troubles.

The early grounds of difficulty, which made the first steps in the adoption of the principles of superheat into steam practice so tedious and prolonged, were mainly those concerned with materials.

The adaptation of high temperature to the then existing engines and boilers met with troubles developed by the burning out of packings, destruction of lubricants, and excessive expansion in valves and in cylinder constructions. It was only when these had become fully understood, and when the advances in steam engineering had paved the way by developments of engine design, that the type of engine for the use of high degrees of added heat came into existence. That these engines have been mainly of European design is due, no doubt, to the particular view of the scientific side of this subject which Thurston described.

Steam Jackets and Reheaters.

The much discussed subject of the value of the steam jacket on engine cylinders has been still further complicated by the introduction of superheat to the steam supply, and experiments continue to attract observers as to comparative results with or without the jacket under various combinations of superheat.

The experiments conducted by M. Ch. Compère and reported by him last year to the Société des Ingenieurs Civils, were not conclusive as to this subject, though highly commendable on account of the introduction of the element of boiler combinations. They do show, however, that a relative advantage gained in cylinder work may readily be lost by inefficient use of flue gases for superheating purposes, and with saturated steam at 6 kilos pressure, results in fuel consumption per effective horse power were obtained, as good as, or even better than those with superheated steam at 7 kilos and temperatures of 270 degrees to 295 degrees Centigrade. The tabulated results are given at the top of the opposite page.

Some extremely practical and valuable experiments were contributed last year by Herr E. Josse in the direction of double, or rather secondary, superheating—a process by which the steam supply to a second cylinder of a compound engine receives, from waste gases, a certain degree of added heat to its supply after exhaust from the

AT PRESSURE OF 6 KILOS. FIRST CYLINDER STEAM-JACKETED.
Saturated Steam.

Fuel.	Evap. per kg. of Dry Fuel.	Eff. H.P.	Steam per Eff.H.P.	Fuel per Eff. H.P.	Superheat Temp.	Pressure at Boiler.
Briquette	8.84	126	7.8 kg.	.96 kg.	none	6.55
Briquette	8.88	126	7.6 kg.	.95 kg.	none	6.66
Briquette	8.129	126	7.67 kg.	1.04 kg.	none	6.54
Briquette	7.56	126	7.7 kg.	1.13 kg.	none	6.54
Briquette	8.68	100	7.55 kg.	.92 kg.	none	6.61
Briquette	8.74	100	7.55 kg.	.974 kg.	none	6.58
Coal	8.55	126	7.88 kg.	1.03 kg.	none	6.53

AT PRESSURE OF 7 KILOS. FIRST CYLINDER STEAM-JACKETED.
Superheated Steam.

Fuel.	Evap. per kg. of Dry Fuel.	Eff. H.P.	Steam per Eff.H.P.	Fuel per Eff. H.P.	Superheat Temp.	Pressure at Boiler.
Coal		126	6.58 kg.		295	7.48
Briquette	7.18	126	7.2 kg.	1.0 kg.	271	7.53
Briquette	6.99	126	6.95 kg.	.99 kg.	281	7.56
Briquette	6.76	126	6.9 kg.	1.02 kg.	282	7.5
Briquette	6.6	126	6.64 kg.	1.02 kg.	290	7.6

RESULTS OF COMPÈRE'S EXPERIMENTS WITH STEAM JACKETING.

primary cylinder. Combinations of this order, by reason of the low temperature of the secondary superheating process, offering effective use of otherwise useless flue gases of moderate temperature, open a field of considerable usefulness. The system is not new, for it was employed by George Corliss nearly 30 years ago. If circumstances permit, it would seem to offer possible advantages over reheating by steam the exhaust of high-pressure cylinders.

In the recent case referred to, by careful arrangement of boiler, flues, and engine, such a combination was brought about as resulted in the increase of boiler efficiency from 65.5 per cent to 77.7 per cent, and, with condensing effect added, to a reduction of the coal consumption to 1.23 lb. per effective horse-power hour. The engine was compound condensing, and was so arranged that the high-pressure cylinder was surrounded or jacketed by the waste hot gases, and the low-pressure cylinder was placed in the steam chest on top of the boiler, being thus permanently jacketed by the steam at 175-lb. pressure per square inch, or about 377 degrees F. The supply to the high-pressure cylinder was passed through a superheater, raising its temperature by 300 to 350 degrees F. The exhaust of the high-pressure cylinder was passed through a secondary superheater, adding to it a superheat of about 135 to 160 degrees F.

The boiler gave an evaporation of 8.6 to 8.12 kilogrammes from feed at 32 degrees F. to steam at 212 degrees F., and its efficiency,

which, without the superheater, had been 65.6 per cent, was raised by the addition of the work done by the gases in super-heating to 77.7 per cent, indicating that the waste gases were previously going off at too high a temperature.

The steam consumption of the engine per horse power was as low as 9.55 lb., and an effective horse-power hour was obtained for as low as 1.23 lb. of fuel.

Cylinder Work.

The use of superheated or ad-heated steam has now extended to all classes of steam engines, and these adaptations have established the now well-known feature, that economy is obtainable by the elimination of saturation or moisture, and in especial, that the source of major losses, by cylinder condensation, is directly and favorably affected by the introduction of superheated vapor, whereby not only is the theoretical expansion of the gas more nearly attainable, but by reason of the higher temperature maintained in the cylinder walls, that expansion is effected freed from much of the interfering or detracting elements introduced by the lower temperatures of saturated steam.

To this subject the past ten years of general engineering practice has contributed enlightening definition, and numerous examples now may be cited to show that the major economy is due to the introduction of such ad-heat as shall suffice, in any cylinder, for the elimination of moisture; and that successive improvement, but in a decreasing ratio of extent, is to be accredited to such additional ad-heat as will maintain the average temperature of the cylinder walls nearer to the temperature of the steam during its cycle of work.

The addition, therefore, of such moderate amount of added heat as shall effect the de-saturation of the saturated-vapor supply of any given engine, will effect, in that engine's performance, an undoubted gain, the extent of which will be in proportion to the more or less inefficient conditions normally existent. Such resultant gain is not, however, to be assumed as attainable without cost, for the added heat must be procured by the abstraction of heat from the gases used to produce the steam supply, and if these gases are nicely proportioned to effect their work of steam production, without any waste discharge above a temperature at which superheating can be effected, then more fuel must be burned to produce the added heat.

G. O. M. Olsson of Stockholm (Transactions American Society Civil Engineers, Vol. LIV. 'E, p. 106) stated the case very clearly. For a condensing engine expanding down to one-tenth of an atmo-

sphere, the increase of volume, due to an addition of 212 degrees F. of superheat, will afford, theoretically, about 13 per cent less consumption of steam per hour, and there should be about 7.5 per cent gain in the work of each pound of steam per 100 degrees F. superheat; but this gain is neutralized by the expense of generation to a net gain of 4½ per cent in fuel.

This is a theory based on computation of volumes only, but practically this is all that is effected by superheat in the highest grade of engines in which internal cylinder losses have been reduced to a minimum. There is a greater practical gain in lower grade engines, where the internal condensation is reduced by the superheat.

He considers that in steam turbines the saving is about equal only to the theoretical value, and refers to tests by Chief Inspector Vincotte and others by Professor Schröter, at various loads, with superheat up to 750 degrees F., in which at the most economical load the results were closely to the theoretical value.

In most practical applications of this sort, however, the beneficial effect in the engine is so direct and considerable, that the consumption of steam is actually reduced, and in many instances to such an extent that even with an addition of heat to be provided by the furnace, less fuel is required for the combination. The proportion which such a saving at the engine will bear to the reduction of the fuel at the furnace, will, of necessity, vary very considerably, exhibiting largest results where the engine conditions have been most undesirable, and where the application of superheat thus effects the greatest improvement—an improvement, however, which may be largely negatived at the boiler end by inefficient or undesirable furnace-flue or superheater conditions.

It is just this point to which the past ten years of practice in this direction appear to have led the attention of American engineers, and which now constitutes the feature to which future development may be expected to bring the use of superheat to definite bases of economy.

The haphazard economies that are effected by changing the heat conditions of existing engine, boiler, and furnace combinations, all more or less faulty, or at best unrelated, can not be regarded as conclusive or final, and in place of these will be developed a practice which will introduce the element of ad-heat in those combinations, as an integral part, debited with its true cost in apparatus and heat-absorption, and credited with its due share of the work accomplished as a part of the whole.

The progress of this subject, then, in the last ten years, may be said to have extended over this great step, and to have brought about the recognition of superheating apparatus as a feature in every well considered steam installation. To say that such a step is in itself important is not to indicate its entire effect and importance, for the nature of the subject thus forced upon the attention of the engineer and of the owner of machinery, is such as directly to effect a better understanding of that vitally important, yet long-neglected, part of the combined apparatus of steam production—the fuel-draft and furnace-flue elements.

It has been to the neglect of these features, and to the incredibly wasteful conditions which exist under most steam boilers, that many economic results, by the mere addition of heating surface in the form of superheaters, have been due; and it is not too much to say, even at this late date in engine and boiler engineering, that in the major number of installations it would be possible to produce, by judicious changes effecting suitable relations of fuel to drafts, to grates, and to flues, greater economies than can be accredited to the mere introduction of superheat to the steam supply. Such conditions cannot long withstand the direction of intelligent observation, which this subject of superheat is eminently calculated to afford; and it therefore appears at this time that this matter assumes a wide importance, and may be expected to produce a far-reaching effect upon the economic engineering practice of the future.

The direct and pressing competition of the gas producer and gas engine has already forced the steam-engine and boiler combinations to a second place in the record for economic production of power, and but for the timely development of the steam turbine, would have already changed much of the course of engineering practice. If steam is to retain its place as a method of power development, its whole cycle of operations must come under the definite and concentrated treatment which has been accorded mainly, in the past, to one end of the operation, viz., the steam-cylinder part of the combination.

THE COST OF STEAM AND ELECTRIC LOCOMOTIVE OPERATION.

By Gerard B. Werner.

It is generally recognized that the problems of electrifying heavy railways are wholly financial. There are no mechanical or electrical difficulties in the way. The question is the possibility of enlisting the huge capital necessary for any change so extensive, and that naturally depends in part on the magnitude of the saving to be made. Mr. Werner summarizes the specific answer to that question in a concrete case, and not only exemplifies the mode of solution but shows by this special instance the probable interest of the answer in other cases.—THE EDITORS.

THE final arguments for the electrification of a steam railroad are reduction in operation costs, and increase of earning capacity of the present tracks. There are, of course, several incidental advantages accruing from the use of electricity as motive power which are of considerable importance, although it is difficult to evaluate them in dollars and cents. In this category we may include three: First, the smaller wear and tear on the tracks, structures, and roadbed, due to the absence of the lateral swaying and vertical hammering caused by partially balanced reciprocating parts of the steam locomotive. Second, the elimination of smoke, cinders, and the gases of combustion, under certain conditions, such as those existing in the New York Central tunnel approach to the New York terminus, is a very compelling argument, and further reduces the maintenance of the rolling stock by making the necessity of car-body painting and cleaning less frequent. Third, the greater facility of train movement, which results from the simplicity of control; the greater readiness for service—no time need be consumed in getting up steam, taking coal, or cleaning fires; and a greater factor of reliability in the locomotive unit, by the elimination of fire, boiler, high-pressure steam pipes, etc.

The increased earning capacity of the line with electric operation follows directly from the use of a locomotive of greater horse-power capacity per ton of weight (and the ability to double or triple this capacity by multiple-unit control), which allows the use of higher accelerations, greater running speeds, and trains of heavier composition, not limited by considerations of gradients. The constant-speed characteristic possessed by the three-phase locomotive is another

valuable adjunct in raising the service capacity of the line, by assisting the maintenance of a predetermined schedule, independent of increased train weight or grades.

The present discussion, however, will not treat of the increased earning capacity as an argument for electrification, but will limit its scope to the analysis of the reduction in operating costs to be effected by the substitution of electricity for steam on trunk lines.

The figures to be presented for the cost of steam-locomotive operation were compiled from the annual report of the railroad, for the particular division upon which a complete project for electrification was estimated. The section to be electrified is a part of the main line, double-tracked, 78 miles in length. The profile shows a fairly mountainous character, with maximum grades of 2.0, 2.2 and 2.3 per cent for 11.2, 8.5 and 15.8 miles. The rest is either level or consists of grades between 0.3 and 1.0 per cent. The alignment shows many curves of large radius. The traffic largely consists of freight trains from 600 tons to 1,400 tons, with schedule speeds from 8.7 to 19.6 miles per hour. The passenger trains average 250 tons and make a schedule speed of about 27 miles per hour. The ton-miles per year are enumerated as follows:

Slow freight	1,128,500,000	ton-miles.
Fast "	308,000,000	"
Passenger	111,000,000	"
Total,	1,547,500,000	"

This ton-mileage, for an average train weight of 700 tons, corresponds to 2,211,000 revenue train miles per annum.

Steam Operation.—Upon looking into the last annual report of the railroad in question we find a table of locomotive performance in unit costs, itemized as follows:

	Cents per locomotive mile,
Repairs,	7.25
Wages, Engineers and Firemen,	7.63
Roundhouse men,	1.42
Fuel,	8.52
Operation of Fuel Stations	0.25
Water supply,	0.27
Oil, waste and other supplies,	0.87
Total,	26.20 cents.

The total of 26.2 cents per locomotive mile, on superficial examination, appears very gratifying indeed, and, as far as it goes, the "Total" is quite correct. But it does not include every item, which is duly chargeable to locomotive operation. The various amounts omitted from the above table may be conveniently divided into:

(a) Fixed charges on the locomotives,
(b) Maintenance and depreciation on roundhouses,
(c) Other expenses on the roundhouses,
(d) Maintenance and depreciation on shops,
(d[1]) Maintenance and depreciation on shop machinery and tools,
(e) Other expenses on shops, such as heating and lighting,
(f) Maintenance and depreciation of fuel and water stations.

Items (c) and (e) will include the interest charge on the capital invested.

The fixed charges on the locomotives comprise interest, insurance, and depreciation. These charges are generally lumped together in the railroad report, with similar charges for other equipment (cars, floating equipment, shops) in the form of a sinking fund for the whole. Sometimes the locomotive depreciation charge may be recognized under "locomotives—renewals." So that the fixed charges are best calculated from the data contained elsewhere in the report.

From a study of the time-table of the road, and based on an average daily mileage of 140 miles per locomotive, we find 43 locomotives are required for the revenue-bearing service of 2,211,000 train miles (assuming no pushers). This figure checks with the number required over the entire division, and may be taken as tolerably correct. Now the report shows that about 20 per cent of the entire number of locomotives are continually undergoing repairs, or otherwise temporarily out of service, and 11 per cent are required for switching service; so that a total of 60 locomotives are required for the 2,211,000 train miles, or one locomotive per 37,000 miles per annum.

A statement in the report giving the capital charges on equipment, shows that the average initial cost of locomotives for this line (Consolidation and Pacific types) is $13,260. Taking the round number of $13,000 the fixed charges will then be based on an initial investment of $780,000. The amortization charge will be based on a depreciation period of 13 years, which is a fair figure for the average life of a locomotive. The annuity for this period is $60.14 per $1,000, or about 6 per cent. Thus we have the annual fixed charges on 60 locomotives:

	Total	Per locomotive mile.
Interest, 4 per cent on $780,000,	$31,200	1.23 cents
Insurance and Risk, 1½ per cent,	11,700	.46 "
Depreciation for a 13 year period, annuity at $60.14 per $1000.	46,800	1.85 "
Total,	$89,700	3.54 cents.

The maintenance, depreciation and other charges on roundhouses and shops were not obtainable from the report. Recourse had to be made to the report of another system or similar character, the Erie Railroad Co., in which the following items are given for the entire road and a total of 33,139,895 locomotives miles per year:

		Total.	Cents per locomotive mile.
(b+d)	Repairs and renewals—Engine houses and shops,	$308,289.66	0.930
(d[1])	Repairs and renewals—Shop machinery and tools,	261,938.16	0.792
(c)	Roundhouse expenses,	87,556.76	0.265
(e)	Shop expenses—Heating and Lighting,	57,454.56	0.172
(f)	Repairs and renewals—Fuel and water Stations,	74,991.48	0.226

These unit values may be assumed for the road under discussion, without appreciable error; and inasmuch as the sum of these five items is only a small fraction of the total cost of locomotive operation, it may be taken with a fair degree of accuracy.

We now are in possession of data as complete as possible for the cost of steam-locomotive operation. The various items need no particular explanation except a few passing remarks. We will note here that items (c) and (e) are not explicit as to whether the interest or capital charge is included. The calculation of the fixed charges is probably accurate to 5 per cent. All repair items include labor as well as material. Fuel is available at about $1.00 per ton. It will be seen that the fixed charges on the locomotives are about 11 per cent of the total, and therefore should be carefully evaluated in estimates of this kind, where the same charges are made for electric operation.

COST OF STEAM LOCOMOTIVE OPERATION.

	Cents per locomotive mile.
Repairs to Locomotives	7.25
Wages, Engineers and Firemen,	7.63
Roundhouse men,	1.42
" expenses,	0.27
" and shops, repairs and renewals,	0.93
Shop expenses,	0.17
Shop machinery and tools, repairs and renewals,	0.79
Fuel,	8.52
Fuel-station operation,	0.25
Water supply,	0.27
Fuel and water-station repairs and renewals,	0.23
Oil, waste, tallow, and other supplies,	0.86
Interest,	1.23
Insurance and Risks,	0.46
Depreciation,	1.85
Total,	32.13 cents.

THE ELECTRIFICATION PROJECT.

Electric Operation.—A detailed project for the handling of the entire service of this division with electric locomotives of the three-phase type was elaborated both in the technical layout and the financial estimate. The train weights and schedule speeds were only slightly increased above those obtained with the steam operation of the railroad.

The estimate included an entire electric equipment, comprising a power house, located at about the center of the system, of 10,500-kilowatts capacity in three steam turbo-generator units; a double transmission line, operating at 33,000 volts; eighteen sub-stations of 12,250 kilowatts aggregate capacity, distributed along the line, near to the tracks; overhead working conductors throughout the division for both tracks, sidings, etc., with a normal pressure of 3,000 volts; six 66-ton passenger locomotives and twenty-two 90-ton freight locomotives.

The annual cost of operation was divided into three parts: cost of generating energy, cost of distributing energy, and cost of locomotive operation. Each of these amounts included fixed charges (interest, taxes, insurance and risks, depreciation), labor, maintenance and repairs. In the cost of generation of energy is included, of course, the fuel item.

The cost of generation comprised the following fixed and works charges: interest on building and sites, 4 per cent; interest on power-station machinery, 4 per cent; interest on money expended during construction, 4 per cent; and discount on sale of securities, 4 per cent on 5 per cent of the capital items; taxes, 1.5 per cent; insurance and risks, 1.5 per cent; depreciation on machinery, 3.39 per cent; attendance, $15,000 per annum; coal 2.5 pounds per kilowatt hour at $1.00 per ton; oil, waste, grease, etc., $1,000; miscellaneous supplies, $1,500; repairs to buildings, 1.5 per cent; and machinery repairs, 4 per cent.

In the cost of distribution, the same percentages were used for the fixed charges as above, except the depreciation on transmission line, sub-stations, and trolley line were reckoned at 3.39 per cent, or a 20-year amortization period. The operating expenses included attendance (inspection, etc.), $9,720; repairs to transmission line, 4 per cent, repairs to sub-stations, 2 per cent.

For the cost of locomotive operation, exclusive of power. the fixed charges are similar to those under the two previous accounts, the life of the locomotive being taken as 20 years. The operating expenses cover attendance, $119,040; oil, waste, grease, etc., and also brake-

shoes and brushes, $5,000; repairs at 4 per cent, which corresponds to $1,320 per locomotive per annum.

Throughout the whole compilation, such percentages and amounts were used as were judged amply conservative, and justified by past operating experience in similar instances.

Without going into a detailed statement of the total amounts which make up the annual cost of operation for the 1,547,500,000 ton miles, we will content ourselves in presenting the resulting unit costs.

(a)	Generation, per kilowatt hour,		.46130 cent.
(b)	" " ton mile,		.01619
(c)	Distribution, per kilowatt hour,		.25500
(d)	" " ton mile,		.00898
(e)	Power delivered at locomotive, per kilowatt hr.	(a+c)	.71630
(f)	" " " " " ton mile	(b+d)	.02517
(g)	Locomotive operation per ton mile,		.01440
(h)	" " inclusive of power per ton mile (b+d+g)		.03957

This total of 39.57 cents per 1,000 ton miles, or 27.69 cents per revenue train mile (for an average train weight of 700 tons), includes every amount chargeable to locomotive operation, except the repairs and depreciation to the roundhouse-shop.

These latter, in the absence of complete data, are difficult to estimate; but figures may be deduced from the corresponding amount with steam locomotives. With electric service, the roundhouse and repair shop may be readily comprehended in one building. The inspection and periodical high-potential testing of the electric locomotive is made more quickly and cheaply, and the variety of machine-tool equipment is not so great. With the longer life and smaller cost of repairs, the number of locomotives out of service is smaller, and consequently the roundhouse-shop accommodation capacity is smaller. In the absence of a commutator, the three-phase locomotive does not require extensive repairs to the electrical parts, and all ordinary work may be undertaken by the locomotive crew (the helper can give his entire attention to this work, since only one motorman is required for the actual operation); and the repairs to mechanical parts are limited to the more rugged members of the frame, truck and drivers. All these considerations point to smaller investment and smaller fixed and operating charges for a roundhouse-shop for the electric system of the same ton-mileage traffic. The smaller building and machine equipment show that these charges may be taken at about one-half to one-third those for steam operation. Fifty per cent is the figure used in the table to follow.

Recapitulating in the train mile, instead of ton mile, cost we have the figures tabulated on the next page:

COST OF ELECTRIC LOCOMOTIVE OPERATION.

	Cents per revenue train mile.
Repairs,	1.67
At endance*,	5.38
Oil, waste and supplies,	0.23
Power at locomotive,	17.62
Fixed charges on locomotives,	2.79
Roundhouse-shop repairs, renewals and other expenses,	1.25
Total,	28.94 cents.

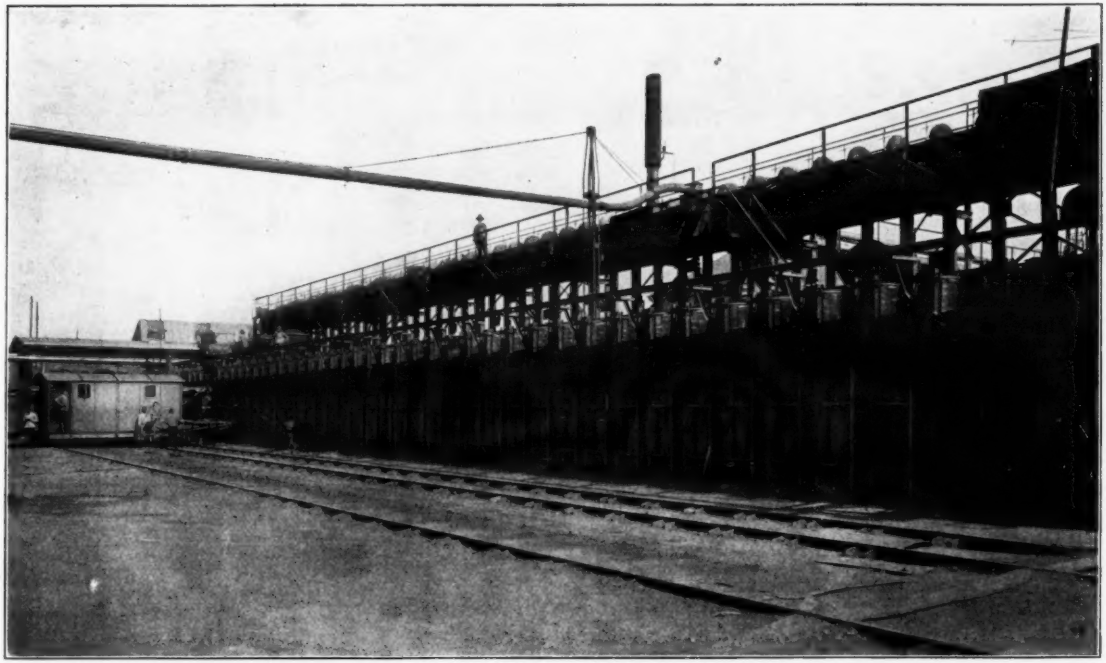
Conclusion.—If the costs for steam operation (page 886) are computed on the revenue train-mile basis, the true and final basis of comparison will be attained. It will be seen that the revenue train-mile cost is about 15 per cent greater than the locomotive-mile cost, since the latter mileage includes the non-revenue-bearing shifting service. The net saving with electricity as motive power due to reduced operating costs is 7.91 cents per revenue train mile or 21.5 per cent, which represents, for 2,211,000 revenue train miles, $174,890.10. This amount, moreover, is equivalent to an additional dividend of about 7 per cent over and above the 4 per cent interest charge on the capital invested.

COST PER REVENUE TRAIN MILE.

	Steam.	Electric.
Repairs to locomotives,	8.32 cents.	1.67 cents.
Wages, engineers and firemen,	8.75	
Wages, roundhousemen,	1.62	
Wages, motormen and helpers,		5.38
Roundhouse expenses,	0.31	
Roundhouse and shop, repairs and renewals,	1.07	1.25
Shop expenses,	0.20	
Shop machinery and tools, repairs and renewals,	0.91	
Fuel,	9.77	
Fuel-station operation,	.028	
Water supply,	0.31	
Fuel and water station, repairs and renewals,	0.26	
Power delivered at locomotive,		17.62
Oil, waste, grease, and supplies,	0.99	0.23
Interest,	1.41	9.76
Insurance and risks,	0.53	0.63
Depreciation,	2.12	1.40
Total,	36.85 cents	28.94 cents

The gain due to increased earnings cannot be predicted without a careful canvass of local conditions. It will be influenced by such factors as the competition of local electric interurban roads, the distribution and prosperity of the population along the line, improvement in the service, and industrial activity in the production and consumption of the articles of freight transported. The probable increase in gross receipts has therefore been omitted from this study.

*Includes inspection at roundhouse.



AN INSTALLATION CHARACTERISTIC OF GERMAN PRACTICE. FORTY-FIVE REGENERATIVE COKE OVENS, KOPPERS SYSTEM, MARIE MINE AT KOHLSCHEID, IN THE WURM DISTRICT.

The pipe extending from the top of the ovens toward the left carries the gas to the power plant.

THE MECHANICAL DEVELOPMENT OF THE GERMAN IRON INDUSTRY.

By J. H. Cuntz.

The review following is concerned chiefly with three important factors which now make for economy in the German iron industry, and which will certainly increase rapidly in importance in American and British practice, under the spur of coming competition. They are by-product coking, the utilization of furnace gases in the gas engine and advanced practice in electric driving of winding and rolling-mill engines. The author acknowledges his indebtedness to Dr. H. Hoffman and to the *Zeitschrift des Vereines Deutscher Ingenieure* for a large part of the data contained in this article.—THE EDITORS.

WHILE giving all due credit to other countries, the fact remains that two of them—America and Germany—have been chiefly responsible for the marvelous growth of the iron and steel industry in the last quarter century. Great Britain, the third great iron-producing country, has hardly more than held her own, although that in itself is a great achievement when her comparatively small natural resources are taken into account, and she can always be proud of having been the leader during the early part of the modern industrial movement, and of having maintained her supremacy for so long.

The production of steel is characteristic of the course of the world's iron trade, the total for all countries in 1880 being about 4,500,000 tons, Great Britain producing 1,320,000 tons, America 1,270,000 tons and Germany 620,000 tons. In 1905, the total steel produced was 43,900,000 tons, America's share being 20,350,000 tons, Germany's 10,070,000, and Great Britain's 5,980,000. The total increase in steel production is therefore about 39,000,000 tons, America contributing 19,000,000 tons of this, Germany 9,450,000 tons and Great Britain 4,660,000 tons. The figures for each of these countries are greater than those for all the world in 1880, America's increase being over four times the total production 25 years ago.

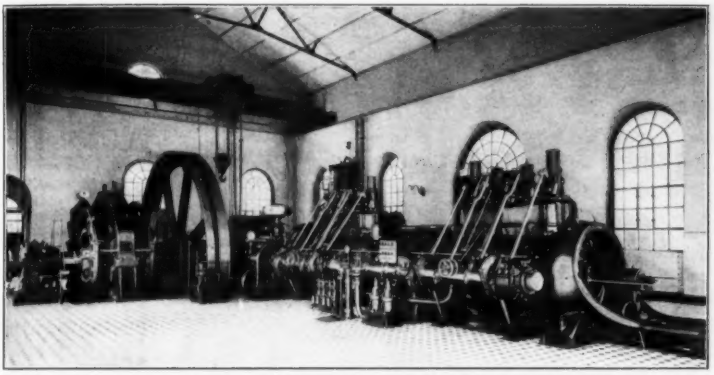
But while the historical development of industry in Germany and America has been similar, there have been other causes which have given the industries of each country certain special characteristics. These causes have been partly natural and partly national. In America, nature has been lavishly abundant in providing the raw materials for manufacture, and the people have been quick to take advantage

of her bounty, but careless in their use of it. The Americans have shown great enterprise and clever ingenuity in their undertakings, and, unhampered by tradition, have built up a very big industrial structure. They have worked quickly, they have gotten results, but not always, not even generally, in the most economical manner. They have not had the time. They have been too busy.

In Germany, on the contrary, while progress has not been so rapid, it rests on a more secure foundation. Inferior to America in natural resources, Germany has made the most of what she possesses. Her people have gone slowly but surely. In America, if a thing does not work right the first time, the tendency is to throw it aside. There is not time to bother about it. In Germany, however, a new invention is thoroughly tried out, and if it is of any value, it is pretty sure to be applied where it will operate most efficiently and do the most good. The Germans have not been slow to adapt American ideas and inventions to their own needs, but there has been far less tendency in America to take up many of the German improvements. This has been the case in the manufacture of iron and steel, and although this industry in America has had such a wonderful growth and is at present in such a flourishing condition, when the evil days come, there will have to be most careful management, not only to maintain the present position, but even to tide over the hard times in any comfort, and every economy will have to be practiced. In those days, if she has not done so before, America will have to turn to Germany for instruction, and it would be well if she could learn her lesson in time to be prepared for the lean years.

A brief review of some of the recent technical developments in the German iron and steel industry will show how it has been infused with the careful, scientific spirit of the nation, and its present condition and tendencies merit the consideration, at least, of the metallurgists of other countries.

The statistics show that Germany's blast furnaces produced nearly 11,000,000 tons of iron in 1905, and their output for 1906 will reach nearly 12,500,000 tons. The production of steel ingots and castings for 1905 totaled 10,067,000 tons, divided according to processes of manufacture as follows: Acid bessemer, 424,000 tons; basic bessemer, 6,204,000 tons; acid open-hearth, 166,000 tons; basic open-hearth, 3,087,000 tons; other steel castings, 186,000 tons, 65,000 of which were acid, and 121,000 basic. This shows the great preponderance of basic processes in Germany, which is due to the character of their ores, and, indeed, it was the introduction of the

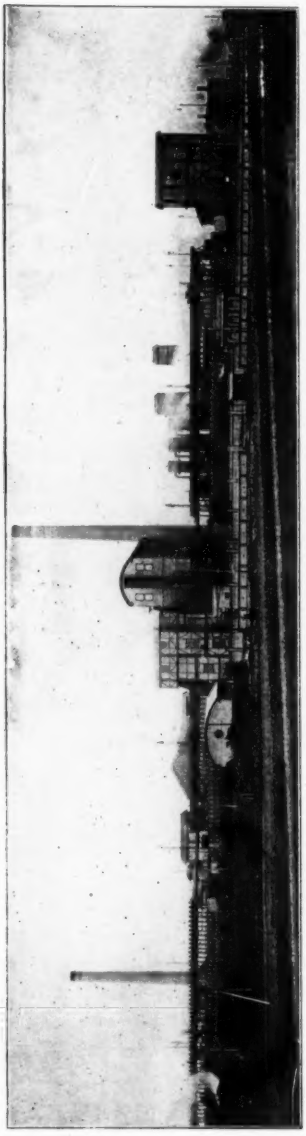


TWO-CYCLE TWO-CYLINDER NÜRNBERGER COKE-OVEN GAS ENGINE WITH 980-KILOWATT SIEMENS-SCHUCKERT GENERATOR AT LUXEMBURGER MINE, BURBACH A. SAAR.

Thomas-Gilchrist methods of lining converters and open-hearth furnaces which made available some of Germany's largest iron deposits, such as the minette ores of the Lorraine-Luxemburg district, which are high in phosphorus, and cannot be worked in acid converters or furnaces.

Next to the raw material itself as an element in the iron and steel industry, comes the power required in all metallurgical operations, and while the character of the materials—the ore, the fuel and the flux—is more or less a fixed quantity for any given region, the metallurgical processes and the methods of obtaining the necessary power for their operation depend largely upon the human element directing them. It is to this question of power production and utilization that much of the attention of German engineers has been given, and recent years have seen a great change, amounting almost to a revolution, in the methods which prevailed up to the end of the nineteenth century.

The German iron and steel works are situated generally where sufficient water power is not readily available, and so they depend almost entirely upon coal as a primary source of energy. Until within the last decade, this coal was used only as fuel for steam boilers, and the reciprocating steam engine was practically the only prime mover. But there has been a great change in the last ten years. The gas engine has come rapidly to the front, and coal, instead of being used directly, is now largely converted into gas and utilized in this form, some gas being burned under steam boilers, but a great and increasing portion being consumed in the cylinders of internal-

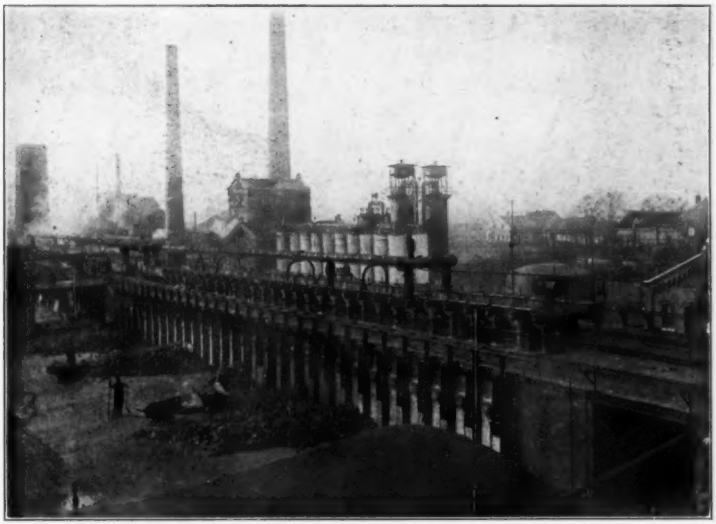


GENERAL VIEW OF A COKING PLANT OF 160 REGENERATIVE OVENS, BUILT BY KOPPERS OF ESSEN FOR THE ESCHWEILER BERGWERKS VEREIN, ALSDORF.

combustion engines. The gas producer, or apparatus whose primary object is the generation of gas for power purposes, finds its principal application in small or moderate sized power plants, but is not used in iron and steel works where there are coke ovens or blast furnaces, as the latter two, while designed primarily for the production of coke and iron, respectively, furnish gas as a by-product, and furnish it in large quantity, even if not of the best quality.

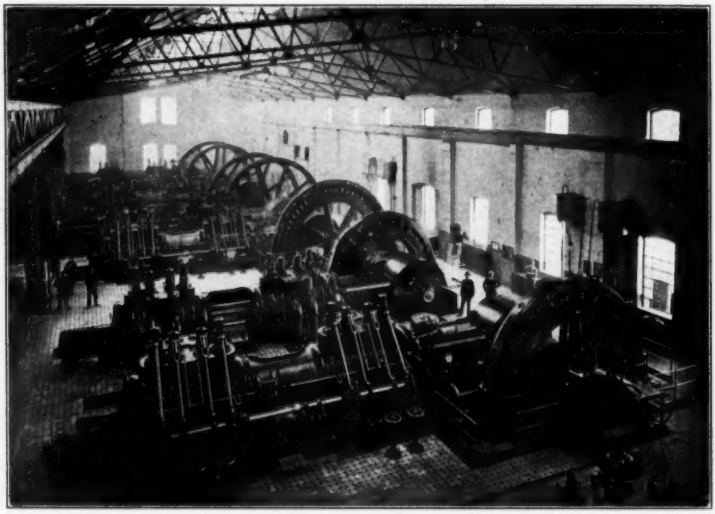
At present about half the coke in Germany is produced in the older style of ovens which burn all their own gas, and from which only exhaust heat is available for steam generation. The other half of the coke is made in by-product ovens, where the gases are cooled and deprived of their tar, ammonia, benzol, etc., and are then used partly for heating the ovens themselves and for generating steam, any surplus being available for gas engines. By constructing these by-product ovens on the regenerative principle, all their gas can be used in gas engines. Hitherto the waste heat and gases from coke ovens have been used principally for steam generation, as they possess a high calorific value and may be consumed under boilers without previous cleaning, which is an expensive

operation with coke-oven gases, but very necessary before they can be introduced into the internal combustion engine. It has been estimated that the gas and waste heat from the coke ovens in Germany are capable of producing from 500,000 to 600,000 horse power, according as they are used for steam generation or in gas engines, or partly for one and partly for the other. Coke-oven-gas engines with a total capacity of 44,000 horse power were actually in use, or in course of construction last summer.



A BY-PRODUCT COKING PLANT OF 120 OVENS.

Blast-furnace gas is a still more important source of power. With a monthly output of 1,000,000 tons of iron, which was slightly exceeded by the blast furnaces of Germany in 1906, it is found that they generate enough gas to produce 1,000,000 horse power if used in gas engines, or about half that amount if burned under boilers in connection with the best reciprocating engines or steam turbines, and only one-third of a million horse power, or less, if used with steam engines such as are often found at metallurgical works and mines. Blast-furnace gas is a much poorer fuel for boilers than coke-oven gas, but when used in gas engines it compares far more favorably with the coke-oven product, as it can there be used to equal advantage by compressing it more highly and by mixing it with a smaller proportion of air. Cleansing of coke-oven gas is more difficult than



GAS-DRIVEN POWER HOUSE, ROMBACHER HÜTTENWERKE. NINE NURNBERGER ENGINES.

that of blast-furnace gas, and with the former the whole cost of cleansing must be charged against the gross power produced, while with blast-furnace gas the purification is largely a matter of removing the dust, and it is also becoming more and more the custom to cleanse the gas before it enters the blast stoves, so that there is but little more purification necessary to fit it for use in gas engines. On account of all these considerations the blast furnace-gas engine has made rapid progress, and in May, 1906, there were in operation or in course of construction in Germany such engines with a total capacity of 372,000 horse power.

These blast-furnace-gas engines are divided according to their type as follows: Two-cycle, 84,000 horse power; single-acting, four-cycle, 40,000 horse power; double-acting, four-cycle, 248,000 horse power. Divided according to their application, there are 200,000 horse power devoted to driving electric generators, 156,000 to blowing engines, and 16,000 to rolling mills.

Of the coke-oven-gas engines, there are 3,500 horse power of the two-cycle type, 4,200 horse power, single-acting, four-cycle, and 36,300 horse power, double-acting, four-cycle. Practically all of these are used for generating electric current.

Regarding the size of the individual engines, 1,000 horse power

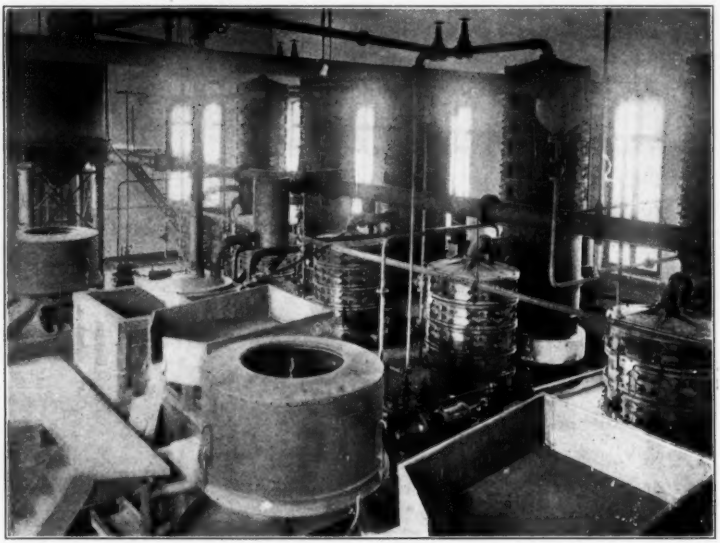
per cylinder is the usual limit, such cylinders having an inside diameter of 1,100 millimeters (43.3 inches) and a piston stroke of 1,300 millimeters (51.2 inches), but the firm of Ehrhardt & Sehmer have built a number of cylinders of 1,150 millimeters (45.3 inches) diameter, with a 1,300-millimeter stroke, which are rated at 1,100 horse power, and the John Cockerill Company has built many 1,200-horse-power cylinders, and has even gone as high as 1,500 horse-power in a single cylinder. The largest gas-engine units, at the present time, develop 3,600 horse power, divided among four cylinders in twin-tandem arrangement.

An approximate estimate indicates that the total power requirements of the German coal mines, iron mines and iron and steel works could be met by the gases and waste heat from the blast furnaces and coke ovens if properly utilized, and with an adequate system of power distribution. These gases are capable of producing about 1,500,000 horse power, but at present the total capacity of blast-furnace-gas engines and coke-oven-gas engines is only about 416,000 horse power. This is being increased, and will undoubtedly become much greater in the course of the next few years, but there is still a wide margin between the power required and that furnished by gas engines, and this gap has to be filled by steam, acting either directly

GAS-DRIVEN MINE POWER STATION, GÜTE HOFFNUNGSHÜTTE.
Six Siemens-Schuckert generators, each 1,009 h. p., 3,200 volts.

in the reciprocating engine or steam turbine, or indirectly through electric generators and air compressors. Some of the steam is generated by the waste heat and gases from coke ovens, but the greater part of the boiler fuel consists of coal, burned directly on the grates

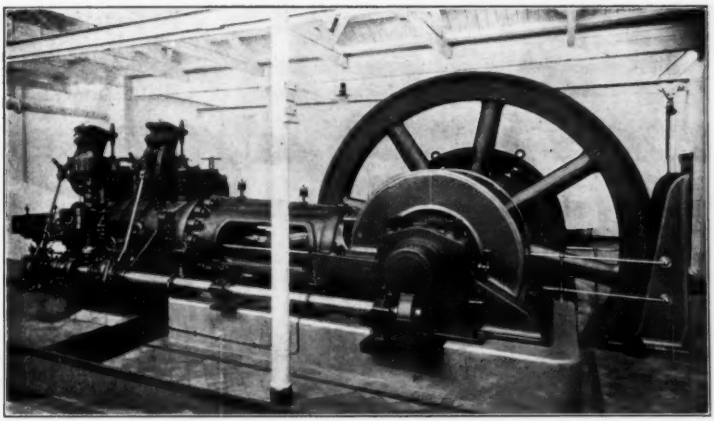
Most of the smaller machines about mines and metallurgical works are now run by electric motors, so that the direct application of the steam engine is confined to the heavy work, such as pumping, hoisting, ventilating, air compressing and rolling. The majority of the blowing engines are now operated by gas, but with this exception, the steam engine is still the chief dependence for working the heavy machinery, although it is being gradually displaced by the electric motor and the gas engine. The steam engines are generally of the compound condensing type, and use moderately high steam pressures.



INTERIOR OF PLANT FOR RECOVERING AMMONIA FROM BY-PRODUCT COKING.

But where steam is used for the generation of electric current, the reciprocating engine is being rapidly superseded by the steam turbine, which seems peculiarly adapted to this work. At mines and works where there is a supply of gas, the gas engine is generally used for driving electric generators, but elsewhere the steam turbine occupies a commanding position in this field. The initial cost of an electric generating plant, including the dynamo, is found to be nearly

the same with both prime movers, when the boiler is taken into account, and amounts to about 200 marks ($50 or £10) per horse power, the choice between the two being determined by local conditions.



DEUTZ GAS ENGINE OF 350 HORSE POWER FOR ELECTRIC CENTRAL STATION OPERATING WITH GAS FROM BROWN COAL.

The large majority of the steam turbines operate with live steam, sometimes superheated, but there is also an increasing use of low-pressure or exhaust-steam turbines. The comparative figures for turbo-dynamos are as follows: At coal mines there are 105,400 horse power of live-steam turbines and 8,000 horse power of exhaust-steam turbines. At works with blast furnaces there are 11,300 horse power turbines using live, and 4,800 horse power using exhaust steam; and at steel works without blast furnaces, live-steam turbines furnish 23,700 horse power, and exhaust steam turbines 1,450 horse power. Besides these there are 46,000 horse power of turbo dynamos not classified, making a total capacity of about 200,000 horse power for steam turbines, as compared with about 243,000 horse power of gas engines, for driving electric generators.

The advantages of electric driving for small machines were recognized at an early date, but it is only within the last ten years that electricity has been applied to the heavy work of pumping, hoisting, etc., and the use of the electric motor for driving rolling mills is of very recent date. Now that electric driving has been made to meet the difficult requirements of a reversible rolling mill, the power-generating plant of a mine or metallurgical work can be completely

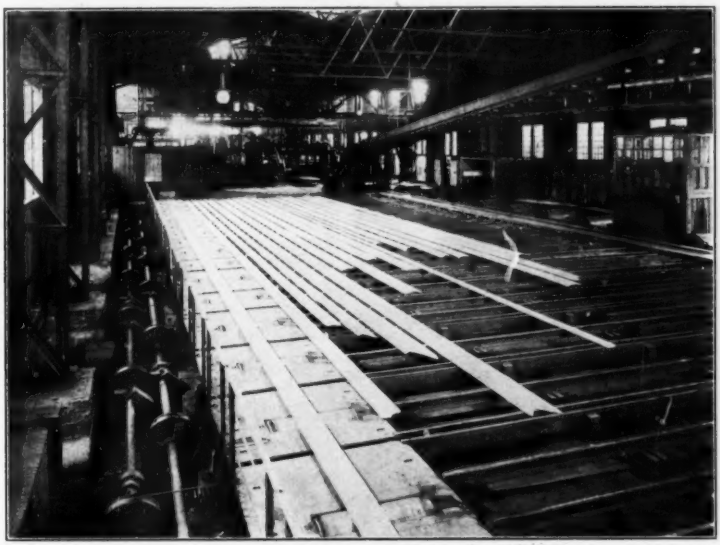
centralized, and electric motors can be made to operate every kind of machine in use. It will be simply a question to be answered for each case individually, whether it is more economical and convenient to drive the machine electrically, or by means of a gas engine or steam engine.

Nearly every mine and works has its own electric station and distribution system, of greater or less extent, but besides the local plants, there are now some great transmission and distribution networks which cover a large area. These larger systems were generally installed originally to connect separated mines and works belonging to the same company or allied companies, and to equalize the power distribution by transmitting the surplus energy at one place to supply a deficiency at another. Such, for instance, is the case where the Stumm blast furnaces at Ueckingen send electric power to their ore mines, 37 kilometers distant, and where the Ilseder works furnish three-phase current at 10,000 volts to the Peiner rolling mills. In many cases plants are connected not so much to furnish each other with a regular supply, as to have a reserve for emergencies or accidents at one place or the other. It is very convenient for a new mine to have a supply of power available, before it has its own coke ovens or generating plant.

The most comprehensive system of equalization and exchange of power is that of the Rhenish Westphalian Electric Company, which operates a network of circuits totaling 1,000 kilometers (620 miles) in length. At present this company has two large stations in operation, and a third is to be built in the southwestern part of its territory, which covers the Ruhr Valley from Hörde to the Rhine. At its Essen station, which is in close proximity to the Mathias Stinnes coal mine, there are two 7,500-horse-power turbo-dynamos, and two similar sets will be running in the near future, besides which several smaller reciprocating-engine sets are in operation. At the Hoerde station, which adjoins the Wiendahlsbank coal mine, there are two generating sets of 3,800 horse power each, and two 7,500-horse-power turbo-dynamos are being installed. The Rhenish-Westphalian Company has closed contracts with some iron works and mines, under which it will buy energy from them for 3 pfennigs (¾ cent or ⅜ d.) per kilowatt-hour, and sell them energy at 6 pfennigs per kilowatt-hour. On account of its connection with various private stations, which enables it to dispense with reserve machinery, this company is in a position to sell current cheaply, its general rate for large customers, such as machine works, rolling mills and mines,

being 6 pfennigs per kilowatt-hour, and where motors are in continuous operation, such as those used for mine ventilators, the rate is as low as 4½ pfennigs.

At coal mines, three-phase current is used almost exclusively. The three-phase motor is well adapted to mining operations, and the voltages employed are high enough to secure economical distribution over considerable distances underground and between shafts. The voltages have risen from 1,000 and 2,000 to 5,000, which promises to become the standard in the Ruhr district. This voltage can be used directly for even comparatively small motors, and at the same time is high enough for the transmission lines of most of the intercommunicating systems. The frequency was formerly 25 cycles per second in many cases, but has now become standardized at 50 cycles.



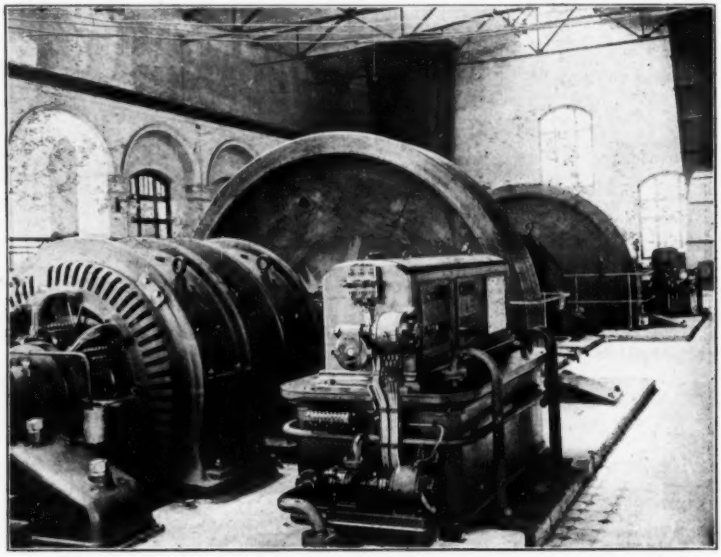
ELECTRIC-DRIVEN ROLLS AND TRANSFER TABLES, LUXEMBURGER BERGWERKS U. SAARBRÜCKER EISENHÜTTEN.

At the iron and steel works, direct current and three-phase current are both used. This field is divided between them pretty evenly, with direct current at present a little in the lead, owing to the flexibility of the direct-current motor and the ease with which its speed can be varied. The voltages run from 220 up to 500.

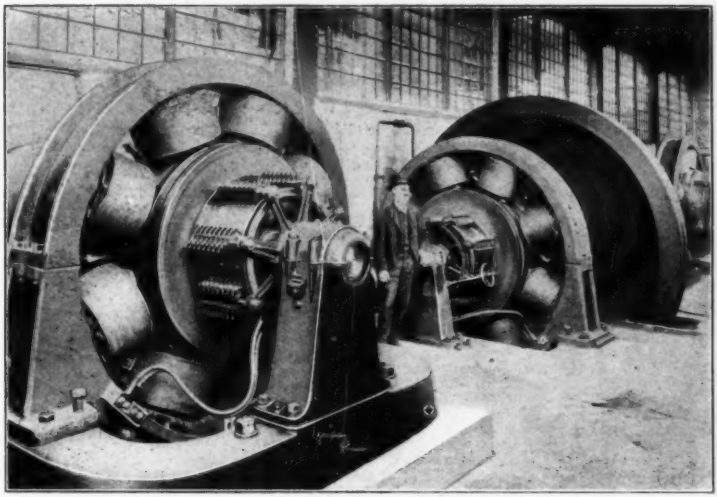
So much for the general features of power generation and distribution. When we come to particular power applications, it is

found that the cranes and other handling apparatus, and practically all the smaller machines at steel and iron works, are now electrically driven. At blast furnaces, the gas engine is being used more and more for running the blowers, and promises to displace the steam engine entirely. The application of gas engines to blowers at steel works has been slower, only a couple of such sets being yet in operation.

The severe demands of rolling mills have, in the past, been fairly well satisfied by the steam engine, but even here the gas engine and electric motor have been able to adapt themselves to the difficult conditions and are working trains of rolls at various mills Both three-phase and direct-current electric motors are used, the latter operating to better advantage under varying speeds. The electric motor has recently been successfully applied to the driving of reversible rolls, the system employed being a combination of the Ilgner flywheel and the Ward Leonard electrical control, which has already met with great success in the operation of mine hoists. In this system there is a motor-generator set with a very heavy flywheel for equalizing the load, the motor being connected to the line, which may have three-phase or any other kind of current. The generator is



WINDING PLANT, ILGNER-LEONARD SYSTEM, MATTHIAS STINNES COLLIERY, ESSEN A. D. RUHR.



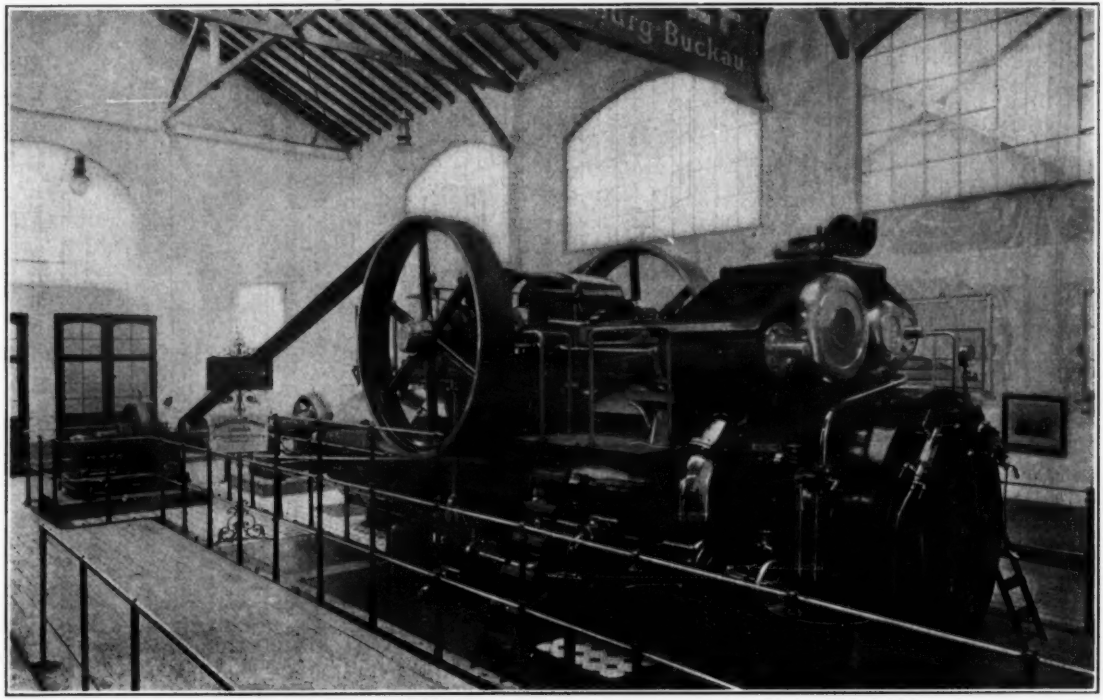
OPERATING MOTOR AND CONVERTER, ILGNER SYSTEM, FOR DRIVING ROLLS.

Built by the A. E. G. for Eisen u. Stahlwerk Bethlen Falva A. G.

a direct-current, shunt-wound machine, whose voltage is varied by altering the field current. The motor which does the actual driving of the rolls, the hoist, or whatever machine it may be attached to, gets its current directly from this generator, and its speed and direction of rotation depend entirely upon the voltage at its terminals, which, in turn, is dependent upon the field current of the generator, which is regulated by the operator. This method of control admits of very nice speed adjustment, in an efficient and convenient manner.

At mines, the electric motor also does a great deal of the light work, although compressed air is still largely employed underground. The air compressors themselves are generally steam driven, but a great deal of the pumping and hoisting is now done electrically.

These great changes in power generation and application have taken place within the past ten years, and they are still going on: Finality has by no means been reached, but the gas engine and the electric motor have gained positions of commanding importance, and promise to be even more generally employed in the future. All over Germany, the great manufacturing companies and the mining and metallurgical engineers appear to be working together to make the very most of their country's natural resources and to raise her to the highest pitch of industrial excellence.



WOLF SEMI-PORTABLE ENGINE, COMPOUND CONDENSING WITH SUPERHEAT.
Normal horse power 186; maximum, 232. R. Wolf, Magdeburg-Buckau, Germany.

THE CHOICE OF MOTIVE POWER FOR THE WORKSHOP.

By Rodolphe Mathot.

III. A COMPARISON OF BURDEN COSTS AND A STUDY OF WORKING EXAMPLES.

In preceding articles in our January and February issues, the author has discussed the relative expense of installation and of operation of plants equipped with steam, gas, and oil engines. He now sums up certain general considerations affecting "overhead charges" against running expense, and concludes with a number of examples of the mode of studying individual problems.--THE EDITORS.

WHEN we include all the accessory work incidental to a motive-power installation, such, for example, as grading, foundations, etc., the total cost is practically the same—that is to say, within 10 or 15 per cent—for all various types of machinery we have been studying. It is necessary, however, to consider the installations absolutely complete, for calculations based upon the price of the principal apparatus without the auxiliaries and the necessary arrangements they involve would be valueless for comparison.

The interest on capital expenditure may be taken uniformly at 5 per cent per annum, whatever type of machinery be installed. So far as concerns sinking fund, it is well to assume a life for the machinery not exceeding 15 years in the case of stationary engines, or 10 years for turbines and semi-portable engines, and of 10 years also in the case of gas engines. The sinking-fund periods which I suggest may appear short; but weight should be given, in my judgment, to the fact that in a limited space of time mechanical construction will have made such progress that it will be of advantage to replace machinery originally installed by new and more perfect apparatus. The old machinery, further, will retain a certain realizable value which will go to diminish the cost of the new machines.

Safety, Regularity and Elasticity in Operation.—The gas motor does not enjoy a very brilliant reputation so far as concerns reliability and elasticity in operation. It has generally attributed to it the fault of stopping for very small causes—a charge which does not lie against steam engines. These, indeed, will run under very unfavorable conditions, of course with an abnormal steam consumption; but rarely is it necessary to shut them down entirely. Indeed, even in the case of accident they may often still keep in more or less

partial operation the machinery which they drive, and it is generally regarded preferable to let them run on, even if in defective order, up to the time when repairs are possible, rather than to be compelled to shut down. The gas engine, on the contrary, if it is not kept up and regulated, so that every part operates normally, refuses absolutely to run at all.

As a result of these considerations the majority of the industrial world looks upon steam engines as being perfectly reliable from the operative point of view and denies these qualities to combustion motors. Therefore, many industrial managers, on the principle that shut-downs are excessively unprofitable, give preference *a priori* and for this one reason alone to the steam engine. This particular state of mind has been perfectly described by Mr. Witz in the comparative review already quoted at the opening of these articles. He says:

> "It is necessary to be certain of living before beginning to think of living well; and continuity of work means more in certain industries than reduction of working cost."

I think, nevertheless, that it would be unwise to generalize from that way of looking at things. Under modern competitive conditions, it is an industrial necessity to live economically and to cut down the general costs of operation the utmost possible. Everything that may contribute to cost reduction ought to be considered, and the judicious choice of the motive power best suited to the particular circumstances of any given installation is always conducive to practical, advantageous results.

We must not, therefore, stop absolutely with this question of reliability; in reality it constitutes often but a superficial element in the problem, and in no case is it in general more important than some one or more of the other points which we have already indicated as worthy of study in the selection of a sysytem of motive power. I have already said, and I repeat and maintain, that a gas engine, well built, well installed, well looked after, is just as reliable as any steam engine. Each type of prime mover, moreover, is individually subject to various accidents peculiar to it. Reciprocating steam engines, turbines, and gas motors are all subject to breakage of parts, and to hot journals. Steam boilers, as well as pressure producers, may explode. The sheets of the fire-box may be burned and steam pipes may burst. I have seen steam engines smashed by water in the cylinders or stopped by a valve seizing, and I have seen gas engines "hove to" by defective ignition. Unquestionably the things which may stop a combustion motor are more numerous and may oftener occur than those causing the shut-down of a steam engine; but for every possi-

ble accident there are plainly indicated preventive precautions, and if these are carefully observed the chances of sudden stoppage are minimized.

In point of elasticity of operation, it is recognized that a steam engine of given power can easily develop 30 to 40 per cent excess for over-load, either by fuller steam admission or by an increase of steam pressure. This latter mode is not to be recommended except under precautions, for there is fear of over-taxing the strength of some parts of the machine. There will, in any case, of course, be some loss of economy, but it will nevertheless be possible to secure the desired result—that is, increased power, at least temporarily. When the over-load occurs but rarely, and lasts but a short time, the increased steam consumption is of little importance.

In any case it would be necessary to figure the additional cost resulting from the conditions, and to compare it with that which would be involved in the installation of a gas engine of sufficient power to carry the maximum short-period load, but operating in general considerably below that duty, and, consequently, under conditions of diminished economy.

Another consideration bearing upon elasticity of operation, and constituting an incontestible advantage for the steam engine, is the ability which it possesses to start into motion the entire transmission system of the factory; if the individual machines are uncoupled it is not necessary to install any main clutch or other uncoupling system. The gas motor does not enjoy this advantage, and to start it with certainty it is necessary that the first explosions in the cylinder should have no other resistance to overcome than that of the motor itself. It is therefore generally installed in connection with some system for uncoupling the entire power transmission; this may be by fixed and loose pulley or by a friction clutch, the latter appliance being rather expensive. In the case of motors of more than 100 horse power, started by means of a compressed-air reservoir charged by a small independent motor, the uncoupling mechanism may, indeed, be dispensed with and the whole power-transmission system (unless its resistance is unusually large) may be set in motion by the gas engine acting as a compressed-air motor until the first few explosions have occurred. For this, however, it would be necessary to provide an air reservoir of adequate capacity, much larger than those ordinarily used. The usual size is sufficient to start the engine four times consecutively without allowing the air pressure to drop below four atmospheres, and the compressor which feeds them generally works to ten or twelve atmospheres.

By way of example, a *résumé* is appended of a number of studies made by me at various times for power installations of various sizes.

EXAMPLE NO. 1.

50-Horse-Power Motor Installation and Heating Plant for a Linen Laundry.

The prime mover might drive the machines either directly or through transmission, and must also supply electric-lighting current, this latter item corresponding to about 15 horse power effective. The heating system was to keep the whole plant at normal temperature in cold weather and also to supply steam under pressure of about two atmospheres to certain special apparatus. The necessary steam consumption was estimated at 880 pounds an hour maximum for heating and 660 pounds an hour maximum for the machinery.

The works are situated in the neighborhood of Brussels near a water course sufficient to supply the condensers without saving the water of condensation. During the summer the demand for power is 35 horse power maximum and 30 horse power average for 10 hours a day. During the winter it is 50 horse power between 6 and 9 A. M. and between 3 and 6 P. M., and 35 horse power between 8 A. M. and 3 P. M. The space available for the boiler and engine installation is constricted. The disposal of waste of all kinds is convenient and presents no unusual features. Absolute continuity of operation is not a vital consideration.

The problem suggests various solutions.

1.—To use a high-pressure installation supplying simultaneously the steam necessary to run a stationary engine sufficient for the motive-power requirements, and also the steam consumed in the heating plant and drying machines, subject, of course, to the introduction of a pressure reducer in the steam main. This solution was rejected, partly because the space available was too restricted for the installation of a compound condensing stationary engine, and partly, again, because the coal consumption of such apparatus per effective horse-power hour would have been at least 2.5 pounds, representing for an average load of 40 horse power for 300 days of 10 hours each a total annual expense of 2,760 francs ($550 or £110) with coal at 20 francs ($4 or 16 shillings) per ton delivered.

2.—To furnish the heating from a boiler designed to carry 8 atmospheres, but working at 2½ to 3 atmospheres, and to feed steam at this pressure to the special apparatus; to place a reducing valve in the main piping of the heating system lowering the pressure to 0.5 atmosphere; to generate the motive power either by a semi-portable condensing steam engine working at 10 atmospheres, and consuming

at the maximum 1.85 pound of coal per horse-power hour with a working load of 30 to 50 horse power, but capable of developing, when necessary, a maximum of 62 brake horse power. The total annual fuel expense of this power unit, estimating again an average load of 40 horse power, would be 2,016 francs (say $500 or £100); as an alternative to this semi-portable engine might be installed a producer-gas engine of 50 horse power, consuming at full load 1 pound and at half-load 1.3 pound of anthracite coal per horse-power hour, the coal costing 26 francs a ton. Under the same working conditions the annual cost, averaging the consumption at 1.1 pound per horse power delivered, would be 1,500 francs ($300 or £60).

The use of a semi-portable engine would permit the supply of steam from this unit to the drying machines during the summer when the general heating system was not in use, and under these conditions the separate steam boiler need not be fired. I therfore advised the choice of that alternative in the second solution—that is, separate steam boiler and semi-portable engine—in preference to the installation of the separate steam boiler and gas engine, notwithstanding the greater annual economy to the extent of 500 francs apparently shown by the last suggested system. The cost of the installation was as follows:

	francs
Semi-portable steam engine, 43 horse-power, compound condensing,	15,925
Foundations, etc.,	500
Pumps and piping,	765
Chimney (already existing)	
Steam piping,	210
Boiler, 60 square metres heating surface,	6,100
Masonry, flues, etc.,	1,326
Total cost,	24,826

The semi-portable without superheating was chosen, because, first, superheat was of no advantage so far as steam for the drying machines was concerned, and because, further, it would involve an increase of 1,600 francs in the purchase price, while the possible economies obtainable, according to the makers' guarantees, would not exceed ¼ pound of coal per horse-power hour—that is (under the average working output of 40 horse power), 276 francs a year. This economy would not suffice to justify the investment in the apparatus, for which the builder would not give at the outside a guarantee of life beyond five years.

EXAMPLE NO. 2.

Motor Installation of 40 Horse-Power for a Tannery.

The prime mover must drive the machinery by direct transmission and the spent tan bark must be used as fuel. The establishment is in

the south of Belgium. The site for the machinery might be selected according to convenience. Water is abundant. The disposal of waste offers no special difficulty and occasional interruptions in operation would not be of vital importance.

The quantity of waste tan bark produced by the plant being insufficient for the generation of the power required, it would be necessary to supplement it by the use of coal, and the largest possible fuel economy on the part of the engine is therefore requisite. Installations studied for this case were that of a semi-portable steam engine and that of a gas motor supplied by a pressure producer suited for utilizing the tannery wastes.

	francs
1.—Semi-Portable Steam Engine.	
Semi-portable steam engine, tandem compound, condensing, using superheated steam, normally developing 35 horse power but capable of continuous overload to a maximum of 45 horse power, pressure 12 atmospheres,	14,500
Chimney, piping, erection, accessories,	1,700
Special furnace for burning tan bark,	700
Total,	16,900
Total Running Cost, per diem.	
Fuel (tan-bark residues)	
Half time for fireman-machinist,	2
Lubrication, maintenance and repairs,	2.70
Interest and sinking fund,	5.65
Total,	10.35
2.—Gas Engine.	
40 horse-power motor with pumps, accessories, foundations,	11,000
Pressure producer, utilizing tan bark,	8,000
Total,	19,000
Total Running Expense, per diem.	
Fuel (spent tan bark)	
One-half wages for machinist,	2.
Lubrication, maintenance and repairs,	3.40
Interest and sinking fund,	6.20
Total,	11.60

The use of a semi-portable steam engine is, therefore, the most advantageous solution.

EXAMPLE No. 3.

Motive-Power and Heating Installation in a Lithographer's Shop.

The motor was to drive the machinery through a transmission system demanding 40 horse power for 10 hours daily, and also to supply electric lighting to the extent of another 40 horse power during about 1,000 hours a year. The heating system was to maintain a normal temperature in the shop and annexes, the shop being situated in a

large hall lighted through the roof, and enclosing a large cubic space to be heated while at the same time presenting wide areas of cooling surface. The necessary steam consumption was estimated at a maximum of 1,450 pounds per hour.

The works are situated in the surburbs of Brussels near to a small pond. The space necessary for the installation of the machinery might be taken at will. The disposal of waste is not subject to any difficulty, and unbroken continuity of operation is not a vital consideration. The choice of a solution must be governed above all by the highest possible economy of operation. I discarded at the outset the stationary engine and boiler and the semi-portable steam engine as not fulfilling sufficiently well this principal desideratum, more especially as a condensing engine plant would have involved large expense for water supply and cooling arrangements.

My recommendation was: For motive power, two gas engines with suction producers, each one of 40 horse power, operating two dynamos of identical characteristics; for the heating plant, an installation of two low-pressure boilers, placed close to the gas producers so that all the apparatus might be attended to in winter by one man. The total price of the motor and gas-producer installation was 26,000 francs. The service trials of the gas engines gave extremely satisfactory results, the fuel consumption per horse-power hour having varied from 0.7 pound under full load to 0.9 pound at half-load. Further, the daily working expense for coal for the motors did not exceed 5 francs, and the average power developed was 40 horse.

The low-pressure boilers for the heating system, 28 square-metres heating surface each, with their accessories, masonry setting and chimney, cost 6,000 francs.

EXAMPLE NO. 4.

150 Horse-Power Installation in a Brewery.

The motive power was to drive apparatus for treating grain, pumps and water-pressure apparatus, and ice machines, and also to supply current for electric lighting and certain power-transmission machinery. There was already installed in the brewery a suction-producer gas engine of 100 horse power and an internally-fired steam boiler of 80 square metres heating surface, carrying 8 atmospheres and supplying steam both for the heating and cooking apparatus and for an engine of 20 horse power. The works are situated in the suburbs of Brussels near to a brook and with abundant water supply. During the summer, any interruption in the working of the ice machines would be serious, and unbroken continuity of operation is a point of great importance.

In this direction the gas motor already installed had fulfilled the requisite conditions excellently during certain periods, having, for example, run for an entire month, day and night, without stop; on the other hand, under different circumstances it had stopped most inopportunely, involving large expense for the purchase of the ice necessary to maintain low temperature in the cellars. It may be observed here that in brewery work any machinery which is in the least likely to refuse to run at the moment when it is needed is generally to be considered as convicted of a capital crime. Gas motors are as yet still in this category.

The question to be considered was: What means would be most economical for generation of the necessary motive power and steam supply to the brewing processes? Should the heating of the vats and the generation of motive power be combined, either by utilizing the exhaust steam or by withdrawing the necessary quantity of steam from a receiver between the two cylinders, or would it be better to keep the two operations wholly independent the one of the other? A builder of stationary steam engines offered for the sum of 22,000 francs (to which must be added about 2,000 francs for erection and connection) to install a compound condensing Corliss steam engine of 180 brake horse power adjusted to run with one-half atmosphere pressure in the intermediate receiver. This engine could have been run by the boiler already installed.

The operation absorbing the largest quantity of heat—about 2,200 pounds of steam per hour—is the treatment of the mixture of wort and hops. When this steam is withdrawn from the intermediate receiver at a pressure of ½ atmosphere, after it has been expanded in the high-pressure cylinder from 7½ atmospheres down to ½ atmosphere, it has already produced 80 horse power of useful work. If the engine at this time is being called upon for 165 indicated horse power (for example) there must be supplied to the high-pressure cylinder in addition 1,125 pounds of steam, which, expanding normally through the high and low-pressure cylinders, will produce the necessary supplementary 85 horse power. The total steam consumption is then 3,325 pounds per hour, or (dividing by the 165 horse power developed) 20 pounds per indicated horse-power hour. When the engine runs without any withdrawal of steam from the receiver it consumes 13.2 pounds of steam per indicated horse-power hour.

To sum up: under the conditions we have been considering it is possible to utilize for heating purposes 2,200 pounds of steam which have already served to develop a certain amount of power; but the total power obtained costs in the average 6.8 pounds of steam per

horse-power hour *more* than the normal consumption when the engine is operated without any steam withdrawal from the receiver. For 165 horse power developed this amounts to 1,120 pounds of steam per hour. In reality, therefore, the advantage gained in steam obtained for heating purposes without expense amounts only to the difference between 2,200 and 1,120 pounds; that is, to 1,080 pounds per hour.

Account must be taken of the fact that steam consumption calculated on the indicated horse power hour is understood to be with no allowances for loss, and that about 10 per cent must be added for condensation losses. A further consideration must be faced in the fact that the existing heating appliances are supplied by steam under high pressure, and that it would be necessary to make changes before it would be possible to utilize the steam under a pressure of only ½ atmosphere.

Let us now consider the alternative of complete separation of the heating and motive-power services, to be secured by using for the former the boiler already installed, and employing for the latter a semi-portable condensing steam engine with high superheat, working under a pressure of 12 atmospheres on a steam consumption of 10½ pounds per indicated horse-power hour, all losses included, and costing 38,000 francs. The boiler has an evaporating power corresponding to 8.9 pounds of water per pound of coal, while the old stationary boiler evaporates only 7 pounds of water per pound of coal.

In the table following are given the comparative figures for the elements outlined above:

Heating and Power Combined.		Heating and Power Separate.	
Steam used,	2,200 lb.	Heating,	2,200 lb.
	+1,125 "		
Loss,	330 "	Power,	1,730 "
Total Steam,	3,655 lb.		3,930 lb.
Coal Consumption, (7 lb. steam per 1 lb. coal)	522 lb.	Coal Consumption, (8.9 lb. steam per 1 lb. coal).	442 lb.

It is apparent that the second hypothetical solution shows an economy of 15 per cent over the first, and that figuring on a working year of 300 days of 10 hours each, the total fuel economy would amount to 233,000 pounds, costing at 20 francs to the ton, 2,120 francs ($424, or £85). The gross difference in price between the first installation and the second (14,000 francs, but to be reduced to 12,000 francs if count is taken of the cost of the changes which the first solution would involve) would thus be repaid in about six years. From these calculations it was decided to adopt the semi-portable engine, and to effect the heating with the old boiler; or, at times when

very little steam was required, to supply the entire service with the semi-portable engine and boiler alone.

Example No. 5.

Installation of 200 Horse Power for Drying and Heating in a Ceramic Factory.

The motor was required for driving machinery by direct transmission and also for supplying electric light, this latter corresponding to about 25 horse power of actual work, while the maximum demand of the machinery would be 155 horse power. Tests which I had made in a similar factory had established the fact that the average power requirement was 100 horse power. The heating of the place would use a quantity of steam approximating 1,980 pounds per hour. The buildings were widely spread out and did not all require heating under the same conditions at the same time. The drying plant (for clays, etc.) required an estimated quantity of 1,100 pounds of steam per hour.

So far as the motive-power installation was concerned, the principal consideration was economy in operation. Space for the installation might be taken *ad libitum*. The removal of waste presented no difficulty and assurance against occasional stoppage in operation was not a controlling consideration.

The factory is built on a hill and the water level is about 80 feet below the surface of the ground. It was therefore necsesary to sink a deep well and the installation for pumping up the water was rather expensive. This made it of interest to use as little water as possible.

After examination of the various conditions to be fulfilled, I recommended the installation of a gas-engine and suction-producer plant of 200 horse power, with starting device operated by compressed air, furnished by an independent compressor driven by a benzine motor. The cooling of the motor is effected by a water circulation on a closed circuit with cooling tower. The plant is situated in Belgium near to the German frontier and to the Liége coal fields. It is therefore easy to procure anthracite coal suitable for a gas producer at a moderate price.

The cost of the installation was as follows:

Motor of 200 horse power with two cylinders twinned; suction gas producer with two scrubbers; water-circulating system with pump and cooling apparatus; compressed-air starting device with reservoir, compressor and 6 horse-power benzine motor,	53,000	francs
Drying installation,	10,000	"
Heating plant for the shops and offices,	19,000	"
Total,	82,000	francs.

EXAMPLE No. 6.

Remodeling of a 400 Horse-Power Plant for a Quarry and Cement Works.

The establishment is in Belgium near to the French frontier, and is built along a watercourse. It comprises two factory buildings, not parallel, and containing cement machinery. The independent power-transmission systems for these two shops are driven by two separate Corliss engines, condensing, supplied with steam from internally-fired boilers. It would be practically impossible to consolidate the two principal transmissions. The new apparatus to be installed was to be erected in another shop independent of the two already existing. The site for this additional machinery might be selected at will. There was no difficulty in the removal of waste, and absolute continuity of operation was not imperative.

There is in the vicinity an electric central station furnishing high-tension current over a radius of several kilometres for quarrying machines of widely-varying capacity, and also maintaining a public and private lighting system. In the interest of stability and regularity of operation this central station desired to enlist among its clients a steady consumer of 300 or 400 horse power. Its management therefore proposed to the owners of the cement manufactory which we are now considering, that these latter should discard their own engines and draw from the central station, at a price to be fixed, all the motive power they might need. This proposal led to the study of the following points:

1.—Actual cost of current from the central station.

2.—Actual cost of the motive power at the cement manufactory with its existing engines.

3.—Cost of power from a separate electric power plant installed at the cement works.

1.—Electric Central Station. This included two tandem compound steam engines, Sulzer type, one of 550 and the other of 350 horse power, supplied with steam, either saturated or superheated as desired, from a battery of multi-tubular boilers. The tests of coal consumption made with these engines gave the following results, under average working conditions, with as wide a range of variation as it had been possible to obtain:

Coal Consumption.	550 Horse Power Engine With Superheat	350 Horse Power Engine With Superheat	350 Horse Power Engine Without Superheat
Per indicated horse-power hour,	2.24 lb.	2.35 lb.	2.62 lb.
Per kilowatt at Switchboard,	4.56 "	4.20 "	4.53 "

The fuel costs of the three engines were respectively:

	Cost per Hour, in Centimes, Coal at 15 francs per ton.		
Per kilowatt,	3.15	2.86	3.10
Per indicated horse-power hour,	1.52	1.61	1.78
Per effective " "	1.70	1.79	1.98

In the average, for the kilowatt delivered to the switchboard the mean cost for fuel alone was 3 centimes. The cost per kilowatt delivered at the cement works, including line and transformer losses, was 3.8 centimes, or, say, per effective horse power delivered to the machines 2.8 centimes. To this figures must be added about 0.25 centime for amortization of the installation necessary between the central station and the power-driven machinery at the plant. The total cost per horse-power hour available would then be 3.05 centimes.

2.—Cement Factory. This contained two Corliss engines, one single-cylinder condensing, the other compound condensing, each developing 150 horse power mean effective. Tests made under working conditions showed that the coal consumption averaged 2.6 pounds per indicated horse-power hour, or 3 pounds per effective horse power per hour at the engine, and 3.15 pounds per effective horse power per hour delivered to the machines. With coal at 15 francs per ton this gives a cost of 2.13 centimes per effective horse power per hour available; with all other expenses of operation and amortization included (representing an item of 0.81 centime per horse-power hour) the figure per horse-power hour delivered at the machines was brought to 2.94 centimes.

3.—Isolated Power Plant for the Cement Works. This installation was studied under three hypothetical solutions:

1. Two semi-portable engines of 200 horse power each.

2. Two gas engines of 200 horse power each with pressure producers.

3. Two gas engines of 200 horse power each, with by-product coke ovens, these being installed without expense for the recovery of by-products, and their coke product being used for cement burning.

I will give merely a *résumé* of the calculations in three cases:

	Semi-portable engine	Gas engines and producers	Gas engines and coke ovens
Initial cost of installation.	130,000	145,000	133,500
Annual running expense and amortization.	44,380	41,813	27,300
Mean cost per horse power hour effective, based on an average of 200 horse power for 360 days of 22 hours; in centimes.	2.8	2.64	1.77

The examination of these figures by the parties interested led the electric central station management to propose to furnish electric current at 4.5 centimes per kilowatt at the switchboard plus an annual charge of 50 francs per kilowatt for 150 kilowatts. An effective horse-power hour delivered to the machinery corresponds generally, considering all losses, to one kilowatt at the switchboard. Under the proposed conditions, therefore, the operation would cost the cement works as follows:

150 kilowatts at a fixed annual charge of 50 francs,	7,500 francs
200 horse power for 360 days of 22 hours each at 4.5 centimes,	71,180 "
Total,	78,680 francs

It is evident that this operating cost is considerably higher than that which would result from an isolated plant at the works; but its acceptance would avoid immobilization of capital, would escape a certain number of more or less expensive difficulties, and would reduce to a minimum the chances of stoppage or shut-down. These various considerations induced the cement manufacturers to deal with the electric central station on the conditions proposed.

Conclusions.

I hope the practical examples given will make it clear that in choosing between the various types of prime mover we must regard carefully every foreseeable condition of general importance. The question must be studied solely from the practical point of view—that is to say, in each particular case we must weigh the various consequences which would follow the selection of a certain form of motor, comparing them with those which would be involved in the selection of every other form, and must reduce to a strict money basis the net result of all these consequences. We must keep in mind that, broadly speaking, the entire installation cost of any one system is about the same as that of any other; that almost always the lowest operating cost is obtained with a gas engine, the semi-portable coming next, and the stationary steam engine last; that there are special considerations in any given case which throw the decision one way or another according to the weight of the influence which they exercise over general conditions of operation. Keeping these elements in mind, then, it is necessary to calculate the total cost per unit of power for each type of power plant in view, taking into account the initial cost of installation and the operating costs. The conclusion as to the verdict we should reach will then be read clearly in the figures obtained—if the studies have been made by a competent engineer who has neglected no essential detail.

COST REDUCTION THROUGH COST COMPARISON.

By C. E. Knoeppel.

Mr. Knoeppel's paper refers only to burden costs. A following article will consider piece, operation, and machine costs, and a concluding one will outline the formation and working of a department of cost comparison.—THE EDITORS.

IN modern business practice the far-sighted executive desires to know, month by month, what his burden has been. He is not content to know simply the amount of money expended, but he wants to know where this money has gone, and if the burden shows an increase, where the increase is as well as what caused it.

A system of costing does not perform its proper function unless its aim is cost reduction. Its aim should be more than simply to furnish data whereby prices can be based, and more, also, than simply to supply the management with an average cost of an article or a burden charge after a period of time. The only proper method of reducing costs is through a systematic comparison, inasmuch as the executive is able to forecast the future only by comparison with past performances.

The progressive manager will not be satisfied with the knowledge that the increase in the burden cost was "only" 3 per cent this month over last, for the result of his efforts may have reduced the burden cost in a certain department 5 per cent, so that in reality there is an increase of 8 per cent to be explained; and as "something" caused this increase, he would not be doing his duty unless he found out what the "something" was. No executive can pass judgment upon an increase in the burden unless he knows where the increase occurred and exactly what caused it. It is strange that managers who pride themselves upon their ability to reduce costs, will shake hands with themselves should the burden show only a "slight" increase, when the result of a comparison and an investgation might result in a quiet, heart-to-heart talk behind closed doors.

The measures of a concern's success is the dividends declared to its stockholders, and I know of cases where the difference between the burden not compared, and what it might have been if investigated

in time, was the difference between dividends and insolvency. I once attended the funeral of a manufacturing enterprise—the forced sale—due to the fact that the management did not know why their burden was high; and the regrettable feature in this instance was the fact that the company could have been successful if their burden had been so arranged as to facilitate comparison. In this case the burden covered a two or three months run, and one set of figures represented the total expenditure, so that it was impossible for the management to point out the weaknesses. The result, as before stated, was failure; and it was due to nothing but the lack of an efficient method of burden comparison.

With the end in view of furnishing an efficient method whereby the executive may compare his costs, I have devised the system here described. It takes care of the burden costs only. The proper comparison of piece, operation, and machine costs will be the subject of another article in the near future. Burden costs are made up by collecting the items of expense from the various departments of the business—from the cash book, ledger, journal, purchase book and perhaps from miscellaneous sources. To group these items in a lump sum is incorrect, for should there be an increase in the burden it is impossible to find what caused it unless the work be done over again and the various items recorded. The burden should be divided into sections to which the various items should be charged.

In formulating the system described, I have made use of the most important principle of advanced accounting—the use of "controlling accounts." To explain this, let me describe a system introduced for a manufacturing enterprise having about 500 accounts. One ledger is used—loose leaf—in which are three ledgers as follows:

General Ledger.
Customers' or Debit Ledger.
Creditors' Ledger.

Besides the general accounts in this General Ledger there are two accounts which represent or "control" the other two ledgers as follows:

Accounts-Receivable Account.
Accounts-Payable Account.

Through this method the only postings made during the month are the postings to the names of the customers and creditors. At the end of the month, however, the Accounts-Receivable Account is debited with an amount which is a total of the postings to the customers' names during the month, while the Accounts-Payable

Account is credited with an amount equal to the sum of the various items posted during the month to the Creditors' Ledger. These two controlling accounts are put through the trial balance, instead of the name of each customer or creditor, thus materially reducing the work of taking off a trial balance. By posting cash received and paid out, one can readily see that a glance at these controlling accounts will show how much is due the company and how much the company owes.

In order to illustrate the method of cost comparison, using the idea before described, I have used seven controlling accounts as follows:

REPAIRS.
POWER, HEAT AND LIGHT.
STOCK ROOM.
GENERAL EXPENSE LABOR AND MATERIAL.
SUPERVISION AND RECORDS.
GENERAL EXPENSE.
SELLING EXPENSE.

These accounts are subdivided into the various accounts they represent or "control" as follows:

MAINTENANCE AND REPAIRS.
- Maintenance of Buildings and General Equipment.
  - 1A—Wages.
  - 1B—Materials.
- Maintenance of Power, Heat and Light Machinery.
  - 2A—Wages.
  - 2B—Materials.
- Maintenance of Machine Tools.
  - 3A—Wages.
  - 3B—Materials.
- Maintenance of Small Tools and Jigs.
  - 4A—Wages.
  - 4B—Materials.
- Miscellaneous Maintenance.
  - 5A—Wages.
  - 5B—Materials.

POWER, HEAT, AND LIGHT.
- 8A—Wages.
- 8B—Materials.
- 8C—Fuel and gas.
- 8D—Miscellaneous.

STOCK ROOM.

9A—Supervision.
9B—Time of handlers.
9C—The taking of inventories.
9D—Materials and supplies.

GENERAL EXPENSE, LABOR AND MATERIALS.

10A—Experimental, alterations and changes.
10B—Teaming.
10C—Miscellaneous indirect labor.
10D—Miscellaneous indirect materials.
10E—Watchman.
10F—Sweeping and cleaning shops.
10G—Handling, loading and unloading materials.
10H—Errors: A—Labor, B—Materials.

SUPERVISION AND RECORDS.

11A—Salaries of executives.
11B—Salaries of heads of departments.
11C—Salaries and wages of clerical force.
11D—Shop supervision.
11E—Shop clerical.
11F—Printing and stationery.

GENERAL EXPENSE.

12A—Taxes.
12B—Water.
12C—Insurance.
12D—Depreciation.
12E—Interest and discount.
12F—Legal.
12G—Freight and express.
12H—Postage, telephone, and telegrams.
12J—Allowances.
12K—Miscellaneous.

SELLING EXPENSE.

13A—Salaries of salesmen.
13B—Expenses of salesmen.
13C—Advertising.
13D—Commissions.
13E—Drawing room time on plans previous to sale.
13F—Materials and supplies.
13G—Office rents and supplies.

FOR MONTH OF April 1906. 35

DATE	ITEM		FOLIO	✓	REPAIRS	POWER HEAT AND LIGHT	STOCK ROOM	GENL EX I & N	SUPERVISION AND RECORDS	GENERAL EXPENSE	SELLING EXPENSE	TOTALS
	AMOUNT BROUGHT FORWARD				1000 00	1200 00	300 00	2900 00	2100 00	2400 00	1000 00	10000 00
	Salaries Heads of Departments-											
	John Williams	$100.00	CB 30									
	William Smith	125.00	"									
	George Wilkinson	75.00	"									
	Freight and Express		Bills						300 00			300 00
	Interest and Discount		L 50							250 00		250 00
	Expense - John Fisher		EB							1050 00		1050 00
	Salary " "		L 30								347 50	347 50
	Advertising - XYZ Magazine		PR 20								250 00	250 00
	Teaming CB 21-30-36-40		CB								50 00	50 00
‡	Repairs to Machine Tools											
	Labor - 200 Hours		TC		.50 00			45 00				45 00
	Repairs to Machine Tools											50 00
†	Invoice Belting	$30.00	PR 21									
	Invoice Grease	27.50	" 22									
	Invoice Wood Pulleys	10.00	" 24		67 50							67 50
‡	Handling, Unloading and Loading											
	Labor - 200 Hours		TC					50 00				50 00
†	New Small Tools- Labor 400 Hours		TC	✓	100 00							100 00
	Executive Salaries -											
	James Johnson	$200.00	L 21									
	George Smith	150.00	L 22									
	William Irving	150.00	L 23						500 00			500 00
	Clerical Force -											
	George French	75.00	CB									
	Phillip James	60.00	"									
	J Snyder	45.00	"									
	Miss Williams	40.00	"									
	Miss Phoenix	35.00	"						225 00			225 00
	New Small Tools -											
	Invoice Cutters	20.00	PR 25									
	Invoice Reamers	10.00	" 25									
	Invoice Novo Steel	100.00	" 26									
	Invoice #2 Steel	25.00	" 27									
	Invoice Chisel Steel	50.00	" 29		205 00							205 00
	Legal- Johnson and Johnson		J 50							100 00		100 00
	Telephone		J 51							100 00		100 00
	Telegrams		J 60							50 00		50 00
	REPAIRS				1422 50							
	POWER, HEAT and LIGHT					1200 00						
	STOCK ROOM						300 00					
	GENERAL EXPENSE LABOR AND MATERIAL							3095 00				
	SUPERVISION AND RECORDS								3125 00			
	GENERAL EXPENSE			✓						3950 00		
	SELLING EXPENSE										1647 50	
	GRAND TOTAL FOR MONTH											13745 00

FORM A. SAMPLE SHEET FROM LOOSE-LEAF RECORD BOOK. SEE PAGE 925.

Inasmuch as "Expense" is charged for amounts expended, I decided to charge the controlling accounts with the expenses incurred during the month, and to credit the sub-accounts with the various amounts that go to make up these controlling accounts. This is of course not carrying out to the letter the principle of controlling accounts as applied to advanced accounting; in fact, the application of the rules of double-entry bookkeeping to this system of cost comparison has not even been attempted; but inasmuch as the controlling accounts are charged for the expenditures, the amounts covering the sub-accounts must, of necessity, fall in the credit column. If the debit total of the "Power, Heat and Light" account for a month is $5000.00, the credits to the sub-accounts—"Wages, Materials, Gas and Fuel and Miscellaneous"—must also equal $5000.00. In this way we have a double-entry system, yet the clerk doing the work need have but little, if any, knowledge of bookkeeping. All that needs to be remembered is that all postings to the controlling accounts should be posted to the left-hand side—all others to the right-hand side.

To illustrate the method of posting we will suppose that during the month an accident occurred to one of the lathes in the machine shop and a force of men were put to work repairing it. This work is covered by "Repairs to Machine Tools," the controlling account being REPAIRS. Ordinarily, if two postings were made for every entry, this repairing would be posted as follows::

Repairs	150 Hours	$50.00	
Machine Tools			$50.00

If, however, we provide a column for all repairs, we do away with the necessity of posting the first item of this entry so that this transaction would be entered as follows:

ITEM		REPAIRS
Repairs to Machine Tools	150 Hours	$50.00

The sums—150 hours and $50.00—would be posted to the credit side of the card representing "Machine-Tool" repairs while the entry to REPAIRS would not be posted until the end of the month, when this amount, along with all the other amounts in this column, would be totaled and posted to the debit side of the controlling account, REPAIRS. This method applied to all the accounts and entries reduces the work of posting to about one-half what it would be if each entry required two postings.

A proper system of time keeping in the shops and a perusal of the books heretofore mentioned will result in the information desired.

Department MACHINE

Charge GENERAL EXPENSE **Number**

PERIOD.	FOLIO.	CHARGES. TIME.	CHARGES. VALUE.	CREDITS. TIME.	CREDITS. VALUE.	BALANCE. TIME.	BALANCE. VALUE.
Jany	3		3700 00				3700 00
Feby	II		4000 00				7700 00
March	2I		3650 00				II350 00
* April	35		3950 00				I5300 00

* denotes posting from "A".

"B"

Department MACHINE

Charge MAINTENANCE SMALL TOOLS * LABOR **Number** M4A

PERIOD.	FOLIO.	CHARGES. TIME.	CHARGES. VALUE.	CREDITS. TIME.	CREDITS. VALUE.	BALANCE. TIME	BALANCE. VALUE.
Jany	4			30	I5 00	30	I5 00
Feby	II			II0	35 00	I40	50 00
March	20			I00	40 00	240	90 00
*April	35			400	I00 00	640	I90 00

* denotes posting from "A"

"C"

Department NOVO STEEL

Charge **Number**

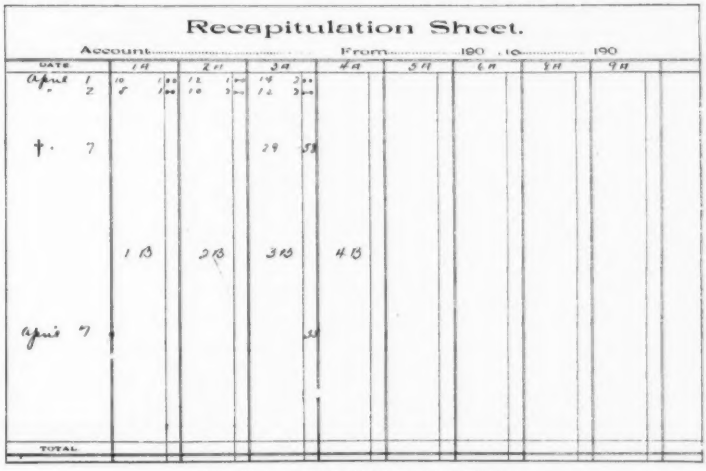
PERIOD.	FOLIO.	CHARGES. TIME.	CHARGES. VALUE.	CREDITS. TIME	CREDITS. VALUE.	BALANCE. TIME	BALANCE. VALUE
Jany	4			50#	35 00	50#	35 00
Feby	I3			I00#	70 00	I50#	I05 00
March	23			I00#	70 00	250#	I75 00
*April	35			I50#	I00 00	400#	275 00

* denotes posting from "A"

"D"

FORMS B, C, D. SAMPLES OF LEDGER CARDS.

For the purpose of recording this information a loose-leaf book should be provided, the various departments being properly indexed. A sample sheet "A" of this book is here shown, which we will say is page 35, covering the closing entries of the month of April. In connection with this system, a set of cards ruled as shown at "B-C-D" are used, which in reality act as "ledger cards." From our "Cost Journal" all the items shown are to be posted to these cards, except those debit entries to the seven controlling accounts, which are not to be posted until the end of the month, as shown by the check mark at "A" and also at "B."

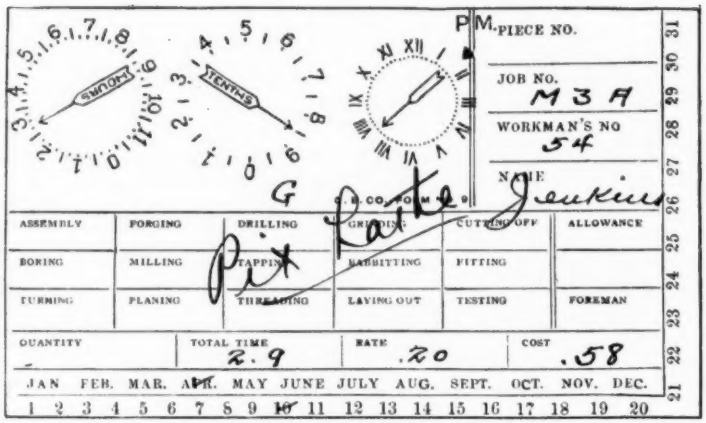

Recapitulation Sheet.

Account..... From..... 190 . to..... 190

DATE		1#	2#	3#	4#	5#	6#	7#	9#
April	1	10 100	12 100	14 200					
	2	8 100	10 300	12 300					
†	7			29 58					
		1 B	2 B	3 B	4 B				
April	7			58					
TOTAL									

FORM F. RECAPITULATION SHEET.

A few words regarding the method of collecting the data for entry to our cost book would perhaps enable one to understand the system more clearly. Form F is a "Recapitulation Sheet," while forms G and H illustrate the means of ascertaining the burden labor and burden material—that is, labor and material that cannot be charged to any particular order number. The various departments are supplied with a list of the charges, and any work done which is not of a productive nature can be classed under one of these heads. The workman or clerk should not determine the charge, for I have in mind an example of the inaccuracy of a workman, who in laying some new flooring to replace a bad spot, charged his time to "Additions to Buildings,"—Permanent repairs being considered an asset by the company, so that the time spent by this workman was posted to



FORM G. LABOR CARD.

assets instead of to repairs. In all cases the purpose should be specified and one who knows can then determine the charge.

Each day the various labor and material cards should be arranged according to the charges, and the totals posted to the "Recapitulation Sheet." Card "G" will show that Jenkins (No. 54) spent 2.9 hours repairing the pit lathe which for the day specified was the only work done on the "machine tools" and is accordingly posted as shown at † on the "Recapitulation Sheet." Form H will show the material drawn to repair this lathe. It will be noticed that the item of belting is ignored, for the following reason: a requisition comes to the office for belting, the purpose being specified as "machine tools." When the invoice covering this belting is entered on the Purchase Record, the amount is charged to REPAIRS and credited to "Repairs to Machine Tools—Materials," as shown at * on Form A. Materials that cannot be posted from the Purchase Record are taken care of from the requisitions, as shown on Form H—set screws and bolts. It can be readily seen that all labor and material not chargeable to a particular order number are taken care of, so at the end of the month the "Recapitulation" can be totaled and the amounts posted to Form A, as shown at ‡ on that sheet.

So far we have taken care of the factory end only. At the top of sheet A it will be noticed that from the Cash Book, page 30, John Williams, William Smith, and George Wilkinson received their monthly salaries amounting to $300.00. As these men are the heads of three departments they come under the head of SUPERVISION AND

RECORDS account, the sub-account being "Salaries Heads of Departments." Instead of charging the ledger card covering SUPERVISION AND RECORDS with $300.00 and crediting the card for "Salaries Heads of Departments" with a like amount, we place $300.00 in the column SUPERVISION AND RECORDS, and when posting simply enter the amount to the credit of the card for "Salaries Heads of Departments." At the end of the month the columns are totaled and the amount representing the expenditure for SUPERVISION AND RECORDS, in this case $3125.00, is posted to the debit side of the card covering this account. This account's six sub-accounts should equal this same amount. This illustration of the first entry applies to all entries.

The characters in the "Folio" column, Form A, are:—CB—Cash Book. L—Ledger. EB—Expense Books. TC—Time Cards. PR—Purchase Record. J—Journal.

Form I shows a draft of a monthly report, and after the entries from book A have been posted and everything closed for the month, the cost keeper can then proceed to make out this report. He can place, we will say, this report and the seven cards representing the controlling accounts on the desk of the manager, who has before him in concise shape all the details as to the month's burden. Reference to B covering the GENERAL EXPENSE account will show him that the amount expended for the month was $300.00 in excess of the amount spent the month previous, and that up to May 1, $15,300.00 has been

MATERIAL DELIVERED CARD.

ORDER NO. M 37	DEPARTMENT. Machine Shop	DATE. April 7-6

QUANTITY	SIZE AND KIND.	VALUE.	
25	Set screws		25
25	double leather belts		
10	Bolts		10
			35

PURPOSE Repairing Pit Lathe

FOREMAN Jones STOREKEEPER. Riley

NOTES. The Foremen in making out Material Delivered Cards, are to specify on same the PURPOSE for which material was used.
In making out Cards, do not specify materials for more than one purpose.

FORM H. MATERIAL CARD.

DEPARTMENT Machine Shop		PERIOD April 1906	
ITEM		AMOUNT	AMOUNT PER HOUR
Repairs		$300.00	
Power, Heat and Light		500.00	
Stock Room		300.00	
General Expense Labor and Matl.		1,000.00	
Shop Expense			$2,100.00 $0.21
Supervision and Records		1,000.00	
General Expense		1,000.00	
Administrative Expense			2,000.00 .20
Selling Expense			600.00 .06
Grand Total			$4,700.00 $0.47
Productive	10,000 Hours		$2,500 Amount
Non-Productive	4,000 "		1,200 "
Burden per Productive Hour	$0.47		
Burden per Productive Value	184 %		
Increase / Decrease Over Last Month	.03	10%	
Increase: / Decrease Over Record Month	.04	12%	
Remarks			
		Signed,	WILLIAMS.

FORM I. MONTHLY REPORT.

expended. If the system has been in operation long enough, a comparison with the first four months of the previous year will be interesting. Should an executive desire it, the idea can be carried far enough to give him the weights and costs of certain materials, as shown on Form D for Novo steel.

If after a study of this report and the seven cards the manager decides that the increase, if there be one, is too large to be passed by without an investigation, he can have placed before him all the cards representing the sub-accounts, and if necessary all the information regarding any entry to any of these accounts.

Through this method of cost comparison the time consumed in looking up time, weights if necessary, amounts expended, etc., is reduced to a minimum; in addition there is placed at the disposal of the executive the means whereby his costs can be reduced, inasmuch as a study of the various items will enable him to study intelligently every part of his business. Another advantage of a method of this nature is the assurance that greater care will be exercised on the part of the cost keepers, when they know that all the details *must* be placed in a permanent record so as to balance, and that the various items *will* be compared.

PROFIT MAKING IN SHOP AND FACTORY MANAGEMENT.

By C. U. Carpenter.

III. THE DRAFTING ROOM AND THE TOOL ROOM—THE HEART OF THE SHOP.

Mr. Carpenter's series began in our issue for January last. The first section traced broadly the problems of reorganizing a run-down concern and the spirit and policy in which they must be approached; the second described the practical and successful working of the committee system, as a means of enlisting the earnest coöperation and the utmost effort of the entire working force. With this secure foundation laid for the work of reorganization, he begins now to take up its actual progress through the concern, beginning logically with the designing and drafting departments and their inseparable ally, the tool room.—THE EDITORS.

"THE secrets of cheap production!" The secrets that every manufacturer ardently desires to discover; that every wide-awake maker of manufactured articles wants to adapt to his own business!

The place of first importance in all the methods and processes that will be considered in this series must be given to the comprehensive Committee System which has been fully treated in the two preceding papers. While the consideration of ways and means of increasing output, lowering cost, and improving quality leads us through a discussion of the several lines of department activities of a well organized business, the underlying principles of the "Committee System of Management" will be constantly referred to, and the great effectiveness of this system constantly employed to help us in solving many an intricate problem of management, method, or processes. Knowing so well its tremendous benefits in the development and management of large industrial enterprises, I consider it the best, and, in fact, the only, foundation upon which to build any thorough plan for reviving a run-down concern, or for developing even a well organized business to its fullest power and possibilities of profit.

ANALYSIS OF DEPARTMENTAL METHODS AND PROCESSES.

The next logical step is the consideration of the designing, manufacturing, and system methods and processes—the consideration of the usual defects, and the determination of plans for remedying them and introducing in their stead the most modern means for efficient, cheap, and accurate production.

THE DESIGNING AND DRAFTING DEPARTMENT.

The secrets of cheap production lie first in the organization of the designing and drafting department, whether it be *two men* or *one hundred,* by methods that:

a—Will develop the possibilities in its working force in both general efficiency and also accuracy in details;

b—Will ensure invariably a design on a new or a re-design on an old product that will bring out the best possibilities of manufacture, both as to ease and cheapness of manufacturing, and the use of standard and stock parts;

c—Will bring about intelligent and sympathetic coöperation of this department and the shop, upon both design and methods;

d—Will result, through the mutual coöperation of designer, draftsmen, foremen and sales department, in a constant striving for new and better designs, a more thoroughly standardized product, and lines of manufacture better suited to the needs of the market and better fitted to outstrip the competitor.

In inseparable association with the designing and drafting department is the tool room, including the tool-designing department. Here indeed is the "heart of the shop." An ill managed, inefficient tool room invariably means a run-down shop. A well managed, up-to-date tool room, headed by a first class, tactful mechanic, thoroughly versed in the possibilities of modern methods, modern tools, modern steels and speeds, should always *head the shop in the right direction* and be *the great factor* in keeping it there if its power is recognized and *properly guided and used.* The general designing and drafting department and the tool room may be properly considered the main levers by which to pry up slovenly and bad manufacturing conditions, and the strongest factors in gaining the desired end of cheap and accurate production. The work of these two departments forms the initiative to modern shop success.

The drafting department, however, does (or certainly should) *originate* the fundamental designs and plans and the accompanying details; yet its work is too often responsible for the "shop deviltry" that shortens the days of many a conscientious factory superintendent; it is the department which is seldom properly conducted, even in well developed concerns, and, in most average or run-down concerns, it is a "fright."

The head of this department, one of critical importance, is often a man of limited shop experience, with little knowledge of methods of adapting design to economical methods of manufacture, no appre-

ciation of the value of standardization or concern for the use of stock parts in designs, but plentifully supplied with the baneful "bump of importance"—the spirit of "know it all." His determination to hold fast to his own ideas is equalled only by his ingenious methods of covering up his mistakes, and an intense jealousy of anyone (especially a shop man) who can or does suggest any improvement in design or method.

Requirements for an Efficient Department.—The first and the absolute requirement for an efficient designing and drafting department is an efficient man to manage and run it. No half-baked offspring of a school nor "graduate" of your existing department will fill the bill. Both this department and the tool room call for men of a high type. The more capable, the better. Men in these positions, if properly handled, should prove to be worth any reasonable sum. This particular man, in addition to being a capable designer and draftsman, should possess a thorough knowledge of the best types of machine tools and the most modern machine methods. He should also have a good knowledge of foundry practise and pattern making. To this necessary knowledge, add tact and a willingness to listen to the shop foreman and to follow stock records in designing new or redesigning old work, and you would have an ideal combination; one so rare, however, that I do not advise anyone waiting to secure a man with this desirable combination of qualities. You might have to wait too long.

These papers will outline methods by which this necessary consideration of shop processes and shop knowledge of the foremen (invaluable as it is) will be fully developed and the valuable points incorporated in this man's work. Whatever his qualifications along the lines mentioned, however, he should invariably be progressive to the last degree—ambitious to a fault. His mind must be open enough to consider the needs of the market from the standpoint of the sales department and the progress of the competitor. He should be in much closer contact with the sales department than is generally considered necessary or even advisable. Indeed, the spirit between designer and sales manager is more often one of hostility than of coöperation. And yet "common horse sense" should teach us that this connection should be a close one. The day of hostility between the factory and selling organizations is passing.

I have discussed at some length the requirements necessary for the head of this department because his *importance is vital;* and also because in most cases the man usually in this position falls far short

of these requirements, and the firm thus fails to realize the possibilities of cheap production.

In many cases I venture to predict that the special conditions of the case are such as to make it impossible to introduce a new man without danger of serious disruption of existing conditions. If such be the case, then introduce methods of organization and management that will check errors, force coöperation between the drafting room and shop, lead to standardization of product, and provide the inspiration for new and better designs through other sources than an inefficient head. Often it is wise to introduce a new head into the department as a "new draftsman," to work "on the table" until he is thoroughly acquainted with conditions and can take hold of the department without danger of disturbance.

The qualifications of the balance of the draftsmen will depend altogether upon special conditions in each case. I cannot pass consideration of them, however, without suggesting methods of training and advancement that will spur them on to do their best.

Bi-weekly meetings will do much good, and, when a draftsman is working upon a special design, meetings with the proper committee will benefit him and improve his work greatly. Encourage your draftsmen to absorb all the shop and foundry practise possible, and to mingle with the shop foremen constantly. Impress upon them the necessity of studying existing machinery and stock conditions.

The general requirements for efficient work in this important department, in addition to those relating to the organization itself, just detailed, can be classified as follows:—

1.—Comprehensive and businesslike coöperation should be established between the designing and drafting departments and the shop foremen. The objects are manifold. Great benefit will be derived from a free exchange of ideas and a free criticism of design by men qualified by shop experience and a knowledge of former mistakes. Assurance will be obtained that every design represents, in its last analysis, the combined knowledge, skill and experience of your best men, and the consequent assurance that when it is produced it will be properly proportioned for strength, will operate properly, and will *be so designed as to be produced in the cheapest manner possible.* Such conferences will also facilitate the proper routing of new work through the shop with reference to the existing conditions of stock output and machinery.

This coöperation, further, will ensure a most thorough consideration of *re-design of regular product*—a question which is of

paramount importance in considering the steps necessary in reviving a run-down concern. The general conditions surrounding the old line of production and the problem facing one in considering the general re-designing of this old line are often well-nigh appalling. But *here you must start and here you must stay* until a general line of procedure is mapped out and progress begun. And, *watch that progress. See that it is made.* Singularly enough (in view of its importance), there is usually a slackening of endeavor, a lessening of effort in the proper direction, after a full plan of this nature is mapped out and work begun. Every excuse of "overload of routine work," "unexpected demands upon time due to unusual conditions," etc., is offered to explain why the necessary progress upon work of a critical nature is not diligently pursued.

Progress every day, if only one new line upon the desired drawing, should be insisted upon, and no excuse for failure to accomplish this little should be accepted. One of the most irritating experiences of the conscientious factory manager is that of lack of progress upon improvements that he knows are vital to the business. *"Same progress every day"* should be unflinchingly called for from those delegated to handle these questions.

2.—Standardization is the second great line of advance to be pursued in the designing department. The entire designing and drafting force, from the head of the department down, should always keep in mind the great benefits to be derived from it. While this applies particularly to lines of product manufactured under special contracts and specifications, at the same time much of its advantage can be applied even to the production of a so-called standard article. In many cases standardization of a product is possible if the sales department can be forced into line and a conscientious attempt made to introduce a standard article on a market apparently requiring goods of special sizes and quality.

The great advantage of this from every standpoint is of course apparent. It means cheapening production through duplication of parts and ease of handling; increase of output per square foot of floor area through quicker production, and the consequent reduction in indirect expense, per piece; the possibility of building for stock in slack times and so keeping up the factory output; quicker deliveries and more orders, better satisfied customers, and a more rapid turning over of working capital—this latter being something that the financial managers of the business will thoroughly appreciate and hail with joy.

The use of stock parts is a profitable step toward standardization even where product in its entirety may not be reduced to standard. The entire drafting force should be provided with books containing full data upon the shop's standard small tools, such as reamers, dies, taps, etc. They should also be continually forced to consider methods of designing so as to use standard and stock parts already manufactured.

3.—Designing so as to ensure cheap machining and assembling is a third prime requirement of drafting-room economy. The men should be continually impressed with the necessity of designing the parts so as to be easily and cheaply machined and assembled, and that, too, upon the types of machine tools already in the shop. The needs of the pattern maker and the possibilities of the foundry should *never* be forgotten. Nor should the tool room and its possibilities in the way of making inexpensive tools be overlooked.

4.—The making and following of drawings should be insisted upon. The designing and drafting department *should make all drawings* of every character. Under no circumstances should any drawings be made by the shop foremen. The up-to-date shop manager will smile at the idea of this being done in this generation; yet I know of several large shops, and many small ones, where this rule is not being enforced, and the shop foremen (in some cases even the job bosses) make many of the detail drawings. In all cases, however, the drawings should be O. K.'d by the shop foremen, either in committee or individually, before they are placed in the shop. The great importance of this is at once apparent. Then, after the drawings are O. K.'d and sent into the shop, *they should be followed.* No deviations should be permitted. If any change is found necessary, then this change should be approved by responsible parties, and made on the drawing.

Reports from the Machine and Assembling Rooms.—Much good can be secured from a simple yet thorough system of reports by the foremen, based upon their actual experience in carrying through their departments a newly designed product, these reports to contain criticisms and suggestions upon design, and ease and cheapness of machining of parts.

In my opinion, all these very desirable results mentioned in detail here can be secured only through the consultation and coöperation of a group of those men best qualified by experience to control and solve the important and intricate problems arising in the consideration of new design or re-design of an old product. I therefore strongly

advise the submission of all of these ideas to a committee formed of the head designer or draftsman, the head of the tool room, and the general factory committee made up of the factory manager, the important machine-room foremen, and the head cost man. This committee should be supplemented from time to time by the presence of the foundryman, the pattern maker, and the stock man. With such a committee handling the questions outlined, the success of the plan is assured.

In cases where the company is fortunate in having an efficient head designer, such a committee will prove a great spur, and of tremendous assistance to him and to the company. Where no efficient head exists, this committee will assume the important *rôle* of "originator of new ideas." Let the head of the company place in the hands of such a committee the general problem of the market requirements regarding a new product, or the necessity of re-designing an old product, from the standpoint of trade requirements as affecting either design or costs of production.

The interest shown by such a group is immediate and intense. The result of their thought and work is invariably so far superior to the work of any one man as to admit of no comparison. Supported by such a system, the work coming from the department will be scientifically designed, correct, with every part mechanically strong, and capable of being produced in the cheapest manner possible. The entire design will represent the best ideas of your best men, and every man through his participation in the particular product will be so interested as to do his level best to make a success of it.

The experienced shop manager has only to consider the usual maddening program of errors in data, mistakes of design, faulty judgment regarding economy of manufacture, lack of standardization of parts, and last, but by no means least, the covert hostility of the shop man to the new productions of "that blamed drafting department," to realize the possibilities which lie in developing methods which will ensure accuracy, economy, standardization, and the interest of the machine foremen in the successful and economical production of any particular design.

The Tool Room.

The tool room has been aptly called "the heart of the shop." It is the most important department in any shop, if its full functions are developed aright. If the designing and drafting department is weak, the wide-awake shop manager can supply the defects through other sources, if necessary; but if the tool room is in an inefficient

condition, the whole shop will invariably be in correspondingly bad shape. A well organized and well equipped tool room, even though it be a very small one, in charge of a progressive, wide-awake, thoroughly experienced man who is willing to coöperate with the balance of the shop, is essential in the reviving of a run-down concern or the improvement of one not "up to the proper mark of efficiency." It is always interesting, when inspecting a shop that is in bad shape, to visit the tool room and note how closely the entire shop conditions conform to the tool-room conditions. At times a good machine-room foreman will build up an efficient department despite a badly managed tool room; but this is rarely the case, owing to the severe handicap of poor maintenance of machine tools, defective design of cutting tools, and the impossibility of securing any accurate, first-class milling fixtures, drill jigs, form cutters, etc., designed to produce the machine work more economically.

It is not my intention to treat here the questions of tool-room equipment and methods of operating a tool-supply room; for these questions have been fully discussed in other articles that have appeared in this Magazine.* The needs of different shops differ, although the equipment of lathes, milling machines, universal milling machines, grinding machines and one or more planers is common to all tool rooms.

A number of systems for tool supply-rooms have been described, so that little need be said on this subject, except to insist upon having some accurate method of caring for small tools, keeping them in good condition, and checking up the workmen relative to those tools in their possession. Some simple system of checking up the men when returning old or broken tools should assuredly be kept. The item of broken tools can become a very large one if the workmen learn that little or no attention is paid to their record in this matter. A simple report showing breakages and the parties responsible for them will enable the shop manager to locate his careless workmen.

My main object in this paper, however, is to bring out clearly the tool room and its functions as factors in the development of a shop toward a high standard of efficiency, particularly when its initial state of efficiency is low; to show how this department can prove its value in making possible the determination of proper standards of production rates, the devising of vital data for a proper wage system, the introduction of economies which the cost system shows are pos-

*See especially the articles by John Ashford, July and August, 1904, and by R. Emerson, Dec. 1904 and Feb. 1905. Ed.

sible, and the lowering of production costs through efficient maintenance of machine tools and the building of new tools especially designed for the particular product manufactured.

The determination of proper standards of production rates is a subject which will be treated fully in a later article. Its great importance is obvious. The possible output of the shop, the lowest possible cost of production, the determination of wage-system standards (in itself a subject of great importance), all depend upon the accurate determination of the lowest possible time in which each piece of work can be completed. The method of keeping the individual workman and the shop keyed up to that rate is an entirely different subject, to be discussed later. But the *initial determination* of this possible speed of production is vital. The necessary tests are by no means simple matters. They involve accurate knowledge of the best results possible from the high-speed cutting tool steel, the proper shape and size of cutting tool, a knowledge of the character of the steel worked upon, and of the greatest capacity of the machine tool used, without too great an expense for maintenance and depreciation.

In ninety-nine cases out of a hundred, the head of the tool room, supplemented by one or two of the best machine-room foremen and the head cost man, form the best group for undertaking this highly important work. Full reports of comprehensive tests made to determine the best production possible from each machine must be made the basis for one line of shop rejuvenation. The investigation of machine-shop processes and methods can best be made by such a group. The result of such action will invariably be as surprising as it is profitable.

The designing of new tools holds great possibilities for economy or waste. Of course, the simple designing and building of new tools in a haphazard manner can be left to the head of the tool department and his tool designer; but only "haphazard results" can be expected. The results attained from this general method will often prove futile, for the head of the department is seldom in a position to determine by himself the most important problems to attack. I have seen the results of many weeks' work in the tool room thrown away almost immediately after the completion of a new set of tools, because of some change in method and design that upon examination proved profitable.

The work of laying out a thorough, consistent, and profitable line of work for the tool room requires judgment of the highest quality. If the original designing or re-designing of the product deserve the

attention of the best qualified men in the organization, formed into a committee, then certainly this even more important and vital work should receive like consideration. In fact, consideration of the design of a new or old product, and consideration of the tools necessary to build the component parts of this same product, go hand in hand.

I therefore urge the serious consideration of the tool problems by the committee formed of the head of the tool room, the head designer, the members of the factory committee, the head of the cost department, and any other of the machine-room foremen in whose departments the work is to be performed.

Keep in mind that the most important—the really vital—" secrets of cheap production," can be solved only by the work of these two departments, and particularly of the tool room.

If your shop is not producing as much as it should, or the costs of production are too high, then *start a campaign of rejuvenation.* But start it through the designing department and the tool room, whether these departments number hundreds of men or but five. Map out a logical and systematic plan of improvement, working through these departments, calling to your aid also the active heads of those departments who meet and conquer the difficulties of manufacture daily, and whose suggestions and aid will prove of peculiar value.

You can thus be assured of a product designed along lines that are practical, accurate, and that meet the requirements for economical manufacture. Coupled with this, you will secure from the work of the tool room and its committee data relative to possibilities of speed of production that are vital, plans for new systems of manufacture that are often radical, and as profitable as they are radical, and plans for new systems of tools that will often revolutionize individual processes and bring about great reductions in costs.

EDITORIAL COMMENT

THE difficulty which the Government has found in closing the contract for the construction of the Panama Canal is one of the most striking demonstrations of the reason why the work should be directed by practical contractors rather than by Federal officials or commissions. A chronological record of the processes of the Administrative mind, in its progress from decision that the contract plan was expedient to renewed indecision about everything, would make the point plain. Just what that schedule is has not been fully published, but it seems to have covered the better part of a year. The plan appears to have been chosen and worked out before or during the summer of 1906; it was formally presented in August; the invitation to bidders was issued in October; now, in March, all bids are to be rejected, and "a new form of contract can be devised .... if it is deemed expedient to do the work by contract."

If this is the pace set by a strenuous President and an energetic Secretary of War, what may we look for when this lauded "direct construction by the Government" is in less vigorous hands? For if this rate and temper are to govern every important move in the construction of the canal, the Twentieth Century will not suffice for its completion.

The whole burden of proof, however, is upon those who assert that the contract plan, followed almost universally elsewhere in our large Government undertakings, is not equally desirable for the Panama Canal. To give their case any standing at all, they should cite at least one conspicuous example of a large and complex engineering enterprise carried to completion, with manifest speed and economy, by day labor under Government engineers and superintendents, instructed and controlled by a Government department or bureau. Is this evidence at hand?

* * *

MR. F. W. HASKELL'S article on The Causes of American Railway Accidents, which we published in the leading position in our issue of December, 1904, (we recalled it also in these pages last November) is now admitted to have been the voice of authority—almost of prophecy. A list of horrors too fearful to realize has been necessary to make the proof clear to some minds, but even the railway journals which tried three years ago to scoff Mr. Haskell out of court have at last admitted that every count in his indictment of our railway systems is true. In some cases the parallelism is striking, as for example:

"Either the flagman or the block signal, if properly performing his or its function, is an absolute safeguard. The two together should make a rear-end collision impossible—but instead of that, by dividing the responsibility, they frequently cause disaster." (Mr. Haskell gives a number of instances of flagmen's neglect to go back) "I have talked to old railway men. The consensus of their statements is this: 'Yes, the rules say so-and-so. But the man who gets his train in on time is the one who makes a record; and the man who, by faithfully obeying orders, gets in the habit of coming in late, is told if he can't make time, some other man will. Oh! if we have a wreck, then it is up to us for disregarding rules.'"—F. W. Haskell, in THE ENGINEERING MAGAZINE, Dec., 1904.

"Unless a block system is absolute it is worse than nothing, for it takes away the sense of responsibility from the engineer. The protection of stalled trains by flagmen is notorious for being neglected, as anyone can testify who has been a passenger on a train stopped between stations."....."An absolute block system is essential, but the men operating the system must be trained to obey the rules absolutely. Most of our accidents are caused by those responsible for the movement of trains being permitted daily to take dangerous chances. Day after day they run past signals to save time and are often commended for getting their trains through on time instead of being punished for violating important rules."—*Railway and Locomotive Engineering*, Jan., 1907.

Or take this, on Mr. Haskell's second great count—the demoralization of discipline by union interference:

"On many roads, the slightest discipline, for any reason whatever, is habitually and persistently combatted and

"The enforcement of discipline on railroads has for years been becoming more and more difficult because of the

resisted by labor organizations. A 'committee' calls to get the reason for the discharge of a fellow unionist. If the cause is sufficient, that sometimes ends it. But frequently the soundness of the reason is disputed; at other times it is recognized, but the official is urged to let the man off 'just this time.' In extreme cases, the reasons are recognized, but the official is ordered to restore the man anyway. But the great evil of 'union' interference is directly apparent in the undermining of the moral sense."—F. W. Haskell, in THE ENGINEERING MAGAZINE for December, 1904.

fact that the labor unions antagonize the management at every possible point. We may cite as a single instance of this influence a case where the management of an American railroad was given the choice of suffering a general strike of machinists or of reinstating a man who had been detected three times making false reports on his time-cards.

"The condition which must be remedied is that railway managements out of deference to public sentiment do not dare to exercise that rigor in disciplining railway employees which the safety of the public demands."—*The Railway Age*, Jan. 4, 1907.

It is scarcely necessary to point out that officials who are regularly conniving at infractions of their own published rules—who are openly known to have one face toward the public and the law and another toward their employees—have already broken down their moral influence and disciplinary power over those employees, and can not blame all their difficulties upon the unions. Probably no other ruling class in the American industrial system have been so self-satisfied, so intolerant of criticism and so contemptuous of "lay" suggestion, as our railway managing officials. There are many signs that they are likely to receive a bitter rebuke, and that from a corrector least discriminating when once aroused—an angry public.

* * *

GREATNESS has been thrust upon American railways by the mere development of the country. They had only to follow—and too often they have dragged. But in qualities of greatness which may be achieved—efficient use of rolling equipment, economy in upkeep of motive power, even-handed justice toward all, reliability to the shipper, safety to the passenger—their showing is not a pride the to Nation, but a shame. *Engineering News* finds a main cause of the disgrace into which we have fallen in the fact that "our Wall-Street railway kings are intent on deals and strategic moves, high finance and underground politics; but they are singularly blind to the fact that the reckless railway operation of the day is creating a strong body of public opinion in favor of Government ownership which must be reckoned with in the near future." This is striking very near the fountain head.

There is, however, a closer relation than might at first appear between the sickening accident record of the past few months and the prevailing inefficiency and low economy in the use of railway equipment and personnel. Unintelligent apportionment of labor, by which men in responsible positions are subjected to destructive overstrain, has played a fearful part in recent notorious wrecks. Unintelligent handling of equipment, and not lack of cars, is the great cause of the so-called car shortage of recent months, which on the one hand left vast sections and interests without the vitally necessary supplies and transportation facilities, and on the other hand clogged the traffic lines to that point of congestion which breeds demoralization and accident. An increase of 25 per cent in the freight cars of the country would demand the entire output of all the car builders of the United States for six years—and the result, as an excellent authority said lately, would be a condition worse than the present, because "they would have more cars to mismanage." An increase of 50 per cent in the freight-carrying capacity of the existing equipment could be secured in six months by applying to the transportation department the same sound, common-sense principles of reorganization and the modern labor-handling methods which have been so successful in the railway shop, as shown in Mr. Jacobs' articles recently published in this Magazine. It would mean only thirty-seven days actual service from each car, in place of the twenty-five now averaged.

Can anyone who has seen the work of the "Industrial Engineer" in the shop or power plant doubt that his science can do even more for the railway? And not only dollars and cents are at stake, but the corporate life of the railroads—and the human life of the passengers.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

ALLOYS OF ALUMINIUM AND COPPER.

A REPORT OF AN IMPORTANT RESEARCH, RECENTLY CONCLUDED, ON THE PROPERTIES OF THE ALLOYS OF THESE TWO METALS.

Prof. H. C. H. Carpenter and C. A. Edwards—Institution of Mechanical Engineers.

THE investigations of the Alloys Research Committee of the Institution of Mechanical Engineers have extended over a period of sixteen years and the results of their labors practically form the entire basis of modern metallurgical theory. Preceding reports have dealt largely with researches on iron and steel, though investigations have also been made on the copper-tin and copper-zinc alloys. The eighth report, recently presented to the Institution, deals with alloys of aluminium and copper. This report covers over two hundred pages and presents a mass of information on the methods of research and on the properties of a large number of alloys of these two metals. It will be impossible in this brief review to do more than indicate the main conclusions arrived at by the investigators.

With regard to the preparation of these alloys, it has been found that, in the case of small castings rich in copper, it is unnecessary to remelt in order to obtain thorough mixing, obviate brittleness, and secure the best mechanical properties. The same is true of the aluminium-rich series; in fact, the results have shown that the best mechanical properties can be obtained by casting at the proper temperature, rather than by remelting. It is possible also to prepare copper-rich alloys satisfactorily from the pure metals and there is no advantage in using a 50 per cent. alloy instead of aluminium.

"The number of alloys that have been found of any industrial and technical promise is small. Such alloys are chiefly those very rich in copper. At this end of the series the limit of serviceable alloys must be placed at 11 per cent. At the other end of the series the limit is even smaller. Among the specifically light alloys rich in aluminium the limit is probably not higher than 4 per cent. of copper. Between 11 and 96 per cent. of aluminium (exclusive) the alloys do not appear to be of any practical promise."

Considering the copper-rich alloys particularly, the report states that "the limit of industrially-serviceable alloys must be placed at 11 per cent. of aluminium. For most purposes the limit might be put at 10 per cent., beyond which there is a rapid fall of ductility with no rise of ultimate stress. It will be noticed however, particularly in the castings, that the yield-point is usually decidedly better at 11 than 10 per cent.

Between these limits the alloys fall into two classes.

(1) Those containing from 0 to 7.35 per cent. of aluminium.

(2) Those containing from 8 to 11 per cent. of aluminium.

Class 1 represents material of apparently low yield-point and moderate ultimate stress, but of very good ductility. The introduction and further addition of aluminium causes a gradual increase of strength, but hardly affects the ductility. It is true that as regards the steadiness of the duc-

tility this has only been established for the rolled bars. But the sand and chill castings have shown the *same kind* of variations as the rolled bars in all the properties examined, and it appears legitimate to draw this conclusion for them also. This class is not very sensitive to heat-treatment, but is much improved by mechanical work.

"Into Class 2 come alloys of relatively low yield-point, but good ultimate stress. From 8 to 10 per cent. of aluminium, the ductility is also good. Certain alloys in this class are very sensitive to heat-treatment, but one of them is remarkably indifferent to hot rolling ('aluminium bronze')."

The low yield-point is characteristic of all these alloys. It has recently been shown that the primitive yield-point of a rolled or forged steel is usually an artificial figure, and is due to a stiffening caused by mechanical treatment. In the case of aluminium-copper alloys however, the primitive yield-point is the true one.

"The alloys containing from 5 to 10 per cent. of aluminium have come well out of the dynamic stress tests. The particular merit of certain of the alloys when tested in alternating stress is the close approximation of the maximum stress under which they will bear an unlimited number of reversals to the stress at the elastic limit as determined in a tensile test. *In this respect they are markedly superior to the iron and steel specimens hitherto investigated.*

"The research has brought to light striking instances of the profound influence of a small quantity of aluminium upon copper, notably in the tension tests, but especially in the torsion and electrical conductivity experiments. One tenth of 1 per cent. raises the angle of twist of copper in torsion 90 per cent.; it lowers the electrical conductivity 23 per cent."

Of the alloy known as "aluminium bronze," the report says:

"The tenacity and ductility of the widely-known 'aluminium bronze' or 'gold,' containing 10 per cent. of aluminium, have been found to be as good in the form of *small chill castings* as in the *rolled bar*, where an 80 per cent. reduction of area of the original ingot has been effected. So far as the authors have been able to learn this result has no parallel."

And further:

"The Research has brought out a fact of very remarkable interest, namely, *that the qualities, both mechanical and physical, of aluminium bronze resemble those of a Swedish Bessemer Steel of about* 0.35 *per cent. of carbon to a truly astonishing degree.* When it is remembered that the former is an alloy of copper and aluminium, the latter an alloy principally of iron, carbon, and manganese, the parallelism of qualities appears especially interesting.

"In the corrosion tests the conditions were made as severe as possible. Thus, if the plates had not been freed from deposit each week by brushing, it is probable that the latter would have protected them to some extent from further action. It was considered important, however, to present the alloys in as unfavorable a light as possible, and to publish *maximum* corrosive figures.

"The alloys containing from 1 to 10 per cent. of aluminium have shown themselves, under the conditions chosen, to be practically incorrodible by sea-water whether alone or bolted to a plate of mild steel. This is an important result. But it must be accepted with this reservation that it does not necessarily hold true in cases where sea-water is exposed to local contamination of particular kinds, for example, town drainage, etc. In the sea-water tests these alloys were undoubtedly superior both to Muntz metal and naval brass, which corroded appreciably.

"The fresh-water tests gave an opposite result. Muntz metal and naval brass were unaffected, whereas the copper aluminium alloys corroded to some extent." On the other hand, the rich aluminium alloys proved to be strongly corroded by sea-water, but uncorroded by fresh water of the type used.

The research tends to show that alloys rich in aluminium are not likely to be of such great industrial importance as those rich in copper though some of them possess important mechanical properties. These alloys are "unaffected by such heat treatment as quick or slow cooling. From 0-8 per cent. of copper all the alloys roll well, and from 0 to about 4 per cent. of copper

they draw sound; but in order to get the full value of the inherent properties of the alloys a considerable amount of mechanical work, e. g., rolling or drawing, with or without annealing, should be performed on them." In one particular alloy (3.76 per cent. copper), "the improvements effected in yield-point and reduction area are particularly noticeable and important. An alloy whose specific gravity is only 2.79, whose yield-point is 18.5 tons, and whose reduction of area is 20.84, may have an industrial future in cases where a combination of lightness and strength is desired.

"The variations of properties caused by the introduction and addition of copper to aluminium have been found to be very similar in the alloys in the form of sheets to those in the form of rolled and drawn bars. In particular, the conclusion previously drawn that nothing is gained by adding more than 4 per cent. of copper has been confirmed by these experiments."

WASTE GASES FOR POWER PURPOSES.

A SUMMARY OF THE CONSIDERATIONS AFFECTING THE UTILIZATION OF WASTE GASES FOR POWER GENERATION IN THE IRON AND STEEL INDUSTRY.

F. E. Junge—Power.

AN article in this number of THE ENGINEERING MAGAZINE contains a reference to the immense amount of power developed from blast-furnace gas in German metallurgical works. The economic importance of waste gases in iron works has not, as yet, been fully recognized in America but increasing attention is being given to the question. *Power* recently published a paper by Mr. F. E. Junge on the subject from which the following extracts, dealing principally with blast-furnace gas, are taken.

"Speaking more particularly of the utilization of blast-furnace gas in the iron and steel industry, which affords, indeed, the most complete exemplification of all the conditions which affect the operation of a power plant, it is known that for various well understood reasons blast-furnace works are preferably combined with steel-smelting plants and rolling mills in order to be able to carry out the entire series of converting and finishing processes which transform the original ore into marketable steel products, all under one ownership and with maximum industrial economy.

"There are several distinct uses to which blast-furnace gas can be put in works of this magnitude, and the soundness of judgment exercised by the designer of the plant in the distribution of such uses will determine, on the one hand, the amount of additional solid fuel that is consumed in the plant in the form of coal or coke and that must be supplied by the works management at extra cost, and, on the other hand, the available surplus power that may be sold to advantage in the neighboring districts or cities, and which will yield remunerative returns in addition to the savings effected within the works.

"The question whether the gas that is produced in the blast-furnace plant is better utilized for the production of heat by firing (besides the hot-blast stoves) open-hearth and other furnaces, or for the generation of motive power in driving blowing engines, rolling mills and central stations, can only be decided after a careful consideration of *all* factors which determine the commercial economy of a plant of this character. Thus we must primarily analyze the relation of the utilization coefficient of the first application, i.e., gas used for heating purposes, to that of the second, i.e., gas for producing power. In some instances, as with the heating of the hot-blast stoves and the driving of blowing engines, the values of the utilization coefficient and load factor are practically identical; but in others there may be considerable difference. So it will often be found that the utilization coefficient of gas for motive power cannot be estimated higher than from 60 to 75 per cent., while the corresponding item of gas for heating purposes may run as high as 85 and even 90 per cent. This difference is naturally founded on the intermittent working of the power plant with its auxiliaries, the

various accessories, like pumps, hoists, fans, etc., showing together an extremely fluctuating load curve, while the various furnaces work almost all day and night continuously, consuming gas at a nearly constant rate.

"The analysis must further embrace a careful comparison of the intrinsic values of the respective fuels which are displaced by the utilization of blast-furnace gas. Thus, if blast-furnace gas is used for raising steam, it displaces coal of inferior quality, while when it is used for firing furnaces it displaces gas coal of higher intrinsic value; and though it is difficult to estimate accurately the gain in favor of the later utilization in exact figures, it must be conceded that in some cases such application will increase the working efficiency of the plant.

"Moreover, there is to be determined whether the lower first cost of the heating appliances against those of a motive-power equipment is a decisive factor in favor of the former application, or whether the far superior efficiency of energy transformation in the latter method is of weightier commercial bearing. . . .

"Since earnest and laudable efforts have recently been made on the part of gas-engine manufacturers to reduce the first cost price per unit of output to the level of steam-engine costs, and since the only difference between the two forms of application consists in the employment with gas power of a cleaning plant as substitute for the boiler equipment, the whole controversy resolves itself into the very simple requirement to provide for a gas-cleaning plant, which is superior in economy, as regards first cost, floor space, water consumption, and skilled labor, to a steam-boiler plant of the same capacity. But even this is no longer a correct argument, since it has been found that in order to get the highest plant efficiency with steam the gas for boiler heating must be brought to almost the same degree of purity as when burnt in gas engines. All other objections are insignificant compared to the simple fact that by the direct utilization of the gas in gas engines, power can be produced at one-third of the cost that is on record for any other form of power generation. . . .

"In the first attempts to utilize the waste gases from blast-furnace plants the hot gas was delivered directly to hot-blast stoves, steam boilers and furnaces laden with dust and at a temperature of from 140 to 160 degrees Centigrade. Needless to say that with such practice it was necessary periodically to shut down the boiler plant for cleaning the settings, besides the cleaning that was ordinarily done as a part of the daily routine of the works, and that the frequent cooling of the boilers subjected them to heavy strains, which greatly impaired their efficiency and necessitated frequent repairs. Furthermore, the heating surface of the boilers would gradually decrease on account of the dust that settled down at a cumulative rate, thereby requiring a constantly increasing quantity of gas for generating the same amount of power.

"The lower heating value of uncleaned blast-furnace gas per unit of volume, and its inferior combustion efficiency when containing considerable quantities of fine dust would anyhow necessitate a larger grate area of boilers, the difference compared to the employment of clean gas running as high as 10 per cent. At the Cockerill works in Seraing, Belgium, it was found that after cleaning a boiler and putting it into commission again it required with dirty gas three hours' time to get up the steam pressure, while by using clean gas this time could be reduced to one and one-half hours. . . .

"One more point, which comes up when studying the physical and chemical properties of blast-furnace gas as an energy-transforming medium, is deserving of consideration, namely, the varying quality of the gas at different stages of the generation process. While the average thermal value of blast-furnace gas lies between the limits of from 100 to 106 B. t. u. per cubic foot, and sometimes even reaches higher values, it often drops down to 90 or 85 B. t. u. per cubic foot in the course of one day's operation. Owing to the working process of the standard type of four-stroke-cycle gas engine, the output of which is rigidly limited by the cylinder suction capacity, the power plant, even when equipped with ample gas storage, is unable to sustain peak loads for any

length of time while the energy of its working medium is thus widely fluctuating.

"Though the automatic gas-supply system eliminates this trouble of inflexibility of engines by providing between the source of gas generation and the prime mover an elastic member, preferably a fan running at variable speeds, with its output automatically regulated from the governor of the engine according to the momentary requirements, thereby securing flexibility and overload capacity similar to steam drive, it is yet desirable that regularity and uniformity of the conditions which affect the working of the furnace directly be likewise maintained."

"Therefore," he adds, "if the varying composition of the blast-furnace gas is uncontrollable, the maintenance of a constant degree of purity of the gas used for heating the blast, as well as the permanent efficiency of the heating surface of the blast stoves, is imperative, as these features increase the working efficiency of the plant. For it must be remembered that all these various niceties of operation help to reduce the amount of manual labor that has to be expended, as well as the quantity of gas required for generating heat and power to carry out the long series of reducing, converting, and finishing processes, thereby eventually decreasing the coke consumption per ton of pig iron smelted, and hence also the total cost of production."

THE INTERNATIONAL OUTLOOK IN THE IRON TRADE.

A DISCUSSION OF THE WORLD-WIDE PROSPERITY OF ALL BRANCHES OF THE IRON TRADE AND OF ITS PROBABLE FUTURE.

J. Stephen Jeans—Manufacturers' Record.

IN the February number of this magazine, there appeared a leading article on the "Development of the American Iron Industry." The author remarked the enormous consumption of iron ore and the consequent immense production of pig iron and steel in the United States and showed that, notwithstanding the immense increase in demand, prices have been kept, until recently, at a reasonable level, largely through the efforts of the great corporations to preserve a steady market. With regard to ore reserves, he estimated that the Lake Superior district alone could supply the total demand of the United States for at least twenty-five years and that therefore with the comparatively undeveloped resources of the South and West, there is no immediate danger of the supply being exhausted, though prices will show a steady advance.

In connection with this paper, it is interesting to read an article by J. S. Jeans, editor of the *Iron and Coal Trades Review*, which was published in a recent number of the *Manufacturers' Record* and which deals with the world-wide prosperity of the iron industry in all its branches and the probable effect on international trade of the continuance or increase of the present enormous demand.

"The future of the iron trade is usually considered under two heads, the first being that of the available supplies of reasonably cheap raw materials, and the second the extent and location of its future expansion. On questions of so problematical a character it is natural that very great differences of opinion should prevail. A Swedish professor recently computed that the ore reserves of the world may be taken at 10,000,000,000 tons, and another writer, well known in the United States, has computed that this reserve will be exhausted in about 50 years. As a matter of statistical curiosity, it may be added that Germany is credited with 22 per cent. of the world's available ore supplies, France and Russia each 15 per cent., the United States 11 per cent. and Great Britain only 10 per cent., Europe being computed as owning more than three-fourths of the iron ores still available for the world's use.

"It is hardly necessary to add that all such estimates are necessarily more or less imperfect and empirical. Yet the attempt to compute the future industrial outlook of different countries, even on imperfect data, is not only fascinating, but prudent, within certain limits. If it be true that the United States has only 11 per cent. of the world's unexhausted reserves of iron

ore, while Germany has not less than 22 per cent., then, so far as the available facts go, the future sceptre of iron supremacy must fall to Germany. No anticipation as to the ultimate destiny of the United States could be more pregnant with great issues. But no good American, and, least of all, no competent judge, is likely to endorse this estimate, having in view the vast unexplored areas of the United States and the relatively well-ascertained geological conditions of the Fatherland. . . .

"It has probably both an academic and a practical interest for business men to see how many years of life, at the present rate of production of pig-iron, the best-known countries are likely to have according to the latest computations. The figures work out as under:

	Pig-iron equivalent of ore reserves in millions of tons.	Term of unexhausted life.
The United States....	603	25
Germany (and Luxembourg)	825	75
Great Britain.....	295	29.5
France	630	210
Russia (and Finland).	637	212.1
Sweden	611	1153
Spain	249	650

"According to these figures, it would appear as if the iron industry of Spain might play the part of Macaulay's New Zealander and survey the ruins of the iron works of the United States, Germany and Great Britain some hundreds of years after the last furnace in these countries had ceased to blow.

"In practice it need hardly be said that no such thing is likely to happen. Indeed, whatever the facts as to unexhausted reserves may be, absolute exhaustion of the iron ores of any country is never likely to take place. There must happen in the utilization of iron ores, as Prof. Stanley Jevons predicated in respect to the coal industry, a long period of declining output, until a stage is reached at which it is no longer profitable to produce the mineral, when the mines must be closed and the furnaces will be blown out in favor of some other country or district whose virgin resources continue to keep it to the front."

The future of the industry will, of course, depend largely on the rate of increase in the demand. In nearly all countries the demand has been steadily progressive. In 1890, the consumption of iron ore in the nine leading countries amounted to 57,066,000 tons; in 1905, it amounted to 111,894,000 tons, an increase in fifteen years of 54,831,000 tons, or nearly 100 per cent. If the demand increases at the same rate for the next fourteen years, the consumption of these countries in 1920 will be well on to 200,000,000 tons.

"Where is the difference to come from? It is perhaps not too much to say that another 100,000,000 tons of ore could not, with our present sources of knowledge, be counted on without at any rate greatly adding to the cost of producing iron ores; consequently, the cost of manufacturing iron and steel would be materially increased. The usual and inevitable effect of increasing the cost of a product in universal use is to limit the demand. This is a law that must apply to iron as well as to other products, and hence we are justified in expecting that higher values will lead to greater economy in the application of iron and steel in all countries alike. Scrap iron will be increasingly sought after, and must increase in value. The more that iron and steel are used the greater must be the quantity of scrap iron available, and this increase of scrap iron will no doubt go some way to fill up the hiatus. Happily, steel is a more durable metal than wrought iron, which it has now so generally displaced. In railway construction steel is generally admitted to have at least three times the durability of finished iron, so that if we had depended on the latter material we should probably have been face to face with an iron famine before now."

The problem of future ore supplies presses for solution in all countries alike, though in the United States, on account of the large reserves still in sight, it has attracted less attention than in most other countries. Great Britain, France and Germany are all large importers of ore and the recent proposals to limit the exports of Spain and Sweden have caused great alarm. Notwithstanding, however, the long-standing impression that Great Britain, Germany and other European countries have reached the extreme limit of their capacity for production, these countries have kept pace

with the general increase in production and too much importance should not be attached to abstract conclusions as to the resources of Europe.

"Two things may ultimately be expected to happen as a result of the exhaustion of iron ores in the older countries. These same countries, we may depend upon it, will not resign this supremacy to newer iron-making countries without a struggle, and are likely, therefore, to engage in a fierce competition to hold their own by imports of foreign ores. On the other hand, the newer countries, with all the advantages that belong to proximity to supplies of raw material, must in course of time take a larger share of the world's iron trade, although which of those countries may hold the primacy, if any of them, in 50 or 100 years from now it would be difficult to say. Canada may be expected to take a more prominent place in this race, and so also with China and Japan."

Each individual country has shown a marked tendency to develop its iron industry along certain special lines. Germany pays special attention to wire and general merchant iron and steel; Belgium to structural steel and rails; the United Kingdom to sheets and plates; while the United States are mainly engaged in producing structural steel, wire and steel rails. It is probable that these marked differences will gradually disappear with the increasing scarcity of raw material, inasmuch as each country aims at complete supply of its own needs.

"To what extent is the demand for iron and steel likely to be increased by opening up new uses for iron and steel, as well as by the supply of the world's wants on existing lines? This is a problem that must greatly influence the situation. I suppose that nearly one-half of all the steel produced in the world today is employed to satisfy uses that had no existence 30 years ago. . . . It would be unreasonable to suppose that this movement will not be carried much farther in the near future. The substitution of steel for timber in the construction of structures of all kinds, including railway cars, must alone bring about an enormous multiplication of new uses. . . . It is hardly necessary to suggest that in the already established uses there is much room for great expansion, and the progress of demand is likely to be large and rapid. . . .

"I should just like to digress here for a moment, in order to call attention to the fact that the United States, while it led the movement for more economical production by cheap freights, larger plants and improved methods and appliances generally, has not today the great lead that it enjoyed ten or even five years ago. In the interval European nations have made enormous advances, and while they are not today on the same all-round level as the United States, they are largely catching up with the best American practice. This is perhaps more generally true of Germany than of any other European country, but it is hardly less applicable to Great Britain, and both France and Belgium are more wide-awake than they have hitherto been. Nearly all the great steel works in Britain have been more or less remodeled, and the most up-to-date appliances are being more readily installed than formerly. As an indication of the recent trend of events, I may allude to the adoption of the Talbot open-hearth process by three important British firms, and the general raising of the efficiency of both blast-furnace and steel-works practice in Cleveland, Scotland, Wales and other leading districts. American iron men would not be well advised, therefore, if they held their competitors cheap.

"In view of the facts and considerations which have been stated in this article, I think there can be little doubt that while we are not likely to be on the eve of an iron-ore famine, and may experience but little real scarcity for some time to come, the tendency will be to appreciate the value of iron-ore properties. This is said, of course, on the same assumption that underlies all attempts to compute the future of the iron industry from the point of view of ore supply, namely, that the world's great deposits are already known."

What we may expect immediately is that "'owners of large bodies of ore, increasing intrinsically in value as rapidly as they must of necessity do under existing conditions, will not be willing to part with their ores except on the basis of very large increase of price.'"

FIRE LOSSES IN THE UNITED STATES.

INTERESTING STATISTICS AND COMMENT ON THIS SUBJECT OF NATIONAL IMPORTANCE.

F. W. Fitzpatrick—The Engineer.

SOME months ago, when the San Francisco disaster was still fresh in the public mind, THE ENGINEERING MAGAZINE published an article on this topic of fire losses, a question of great economic importance. The hope was expressed therein that the immense loss of property by fire in that ill-fated city would at least have the effect of impressing upon the people of the United States the importance and necessity of providing, so far as possible, against the possibility of the occurrence of a like disaster in every other city in the country, not by increased expenditure on fire-fighting forces and appliances, but by a reformation in building methods. An article in a recent number of the London *Engineer* offers some interesting comment on the subject and gives very valuable statistics. The writer, Mr. F. W. Fitzpatrick, is an American who, as Consulting Architect of the International Society of State and Municipal Building Commissioners, is in a position to speak with authority.

Primitive construction was, of course, entirely of wood and the abundance and cheapness of timber long maintained it as the chief material of construction. With the springing up of large cities, disastrous fires became common; but instead of seeking safety in "fire-prevention" by means of improved building methods, the people of the United States have relied, for immunity from the danger of loss by fire, upon elaborate and expensive systems of "fire-protection."

"When it becomes a question of fire, one's mind naturally reverts to water, beautiful fire apparatus, and wonderfully acrobatic men, rather than to the elimination of fuel for that fire. Cities vie with one another, not in how few fires they can have, but in how quickly and well the majority of their fires are extinguished. . . This competition has become keen; to a certain extent it is a fad with our cities, and the cost of maintenance is enormous. In salaries alone the fire departments cost us £28,000,000 a year; high-pressure water and fire apparatus bring the cost of our so-called 'fire protection' to a total of over £60,000,000 a year.

"There is really a premium offered upon poor construction. In San Francisco, for instance, the insurance companies made an exceptionally low rate, spite of the fact that the city was ridiculously wooden and the fire hazard enormous, simply because its fire department was so very excellent. Yet what did it avail? Think of the accidents, even barring earthquakes, that may happen in other cities and that could result in equally great disaster. The expenditure for fire departments is a gamble in protection and grows as our cities grow at an exceedingly lively rate, though there is no reason for such *pro rata* increase. On the contrary, the richer a city becomes, the more buildings it has, the saner it ought to be and the more it ought to reduce its fire risks by strict building regulations and better construction, and consequently reduce its expenditure for so-called 'protection.'

Occasionally, after some great calamity such, for example, as that of the Iroquois theatre, an attempt is made to revise and enforce building laws, but such attempts are usually only spasmodic. Of the 11,500,000 buildings in the United States, there are probably not more than 4,000 that are even moderately "fireproof" and only one, the Board of Underwriters' Laboratory Building in Chicago, which can truthfully be called absolutely fireproof. The rapid exhaustion of the forest reserves of the country has increased the price of timber to such an extent that the initial cost of thorough fireproof construction is only 10 or 12 per cent more than "ordinary" construction in which wood plays an important part. But notwithstanding the obvious savings in the maintenance of a fireproof structure, in repairs, insurance, etc., the people seem to prefer to pay the high insurance rates and gamble on the efficiency of their fire-protection systems. £325,000,000 have been paid in insurance premiums

in the last ten years. In 1905, the return in adjusted losses, out of £39,000,000 paid in premiums, amounted to only £19,000,000.

"No country on earth builds as rapidly and as expensively as we do, and no country on earth needs to build so rapidly, for none destroys its buildings at the rate we do. Not even in Japan and China, the lands of bamboo and paper, are the fire losses as great, in sum, *pro rata* of population, or as numerous or in any way equal to the really indecent losses we indulge in. This year (1906) is a phenomenal building one; so far it has never been equalled. The total will probably reach £125,000,000. Of that vast sum there will be spent not over £15,000,000 in reasonably safe construction, and certainly not £2,000,000 in absolutely fireproof construction—ratios that are far from comforting and that proclaim very loudly that our so-called progress in building is somewhat of a figment of the imagination. We know what is good construction, but we do not apply the knowledge, and we build too hastily and flimsily. Our fire losses have by rapid jumps reached the £40,000,000 mark per annum. But that is normally. Our 1904 losses went up to nearly £50,000,000 on account of the Baltimore fire; San Francisco's fire assures that 1906 will show £100,000,000 loss, at least, and what guarantee have we that some other great disaster will not wipe out ten or twenty millions more? Have we not built so poorly that from now on we must expect that the abnormal year will be, not the one of great disasters, but the one when none occur? The cost of our fires constitutes a tax that is eight times greater than the similar *per capita* tax of all Europe.

"The figures here quoted are official, taken from insurance reports, municipal department statistics, and building inspectors' notes. Yet there are many communities from which imperfect or no reports are received and many fires unrecorded. It is safe to assume, therefore, that those figures are minimum, and really do not represent our total loss. Realising that, and also that February, March, and April seem to be the months during which most fires occur, I went to considerable trouble and expense last year to secure data about absolutely every fire occurring during a period—ten days—chosen at random out of those three months. During those ten normal days 1,315 fires occurred, totalling a loss of £2,960,000. On one day, when all the complicated machinery of getting these returns was in perfect working order—February 23, 1905—when I know that nothing escaped me in all the land, there were 165 fires, doing a damage of £403,000, so that our real fire loss is very much greater than what we have supposed it to be.

"That was a very ordinary, let us call it a normal, day. But here is the other record, that of San Francisco's fire, that lasted three days and swept five square miles of territory, 500 city blocks, or about 25,000 buildings out of existence. It laid bare egregious stupidity on the part of the authorities, the architects and builders. The actual destruction of buildings means £65,000,000 wasted in smoke; £200,000,000 in business lost to the city and the country generally; £2,500,000 to clean up the *débris;* and £70,000,000 more and twenty years' time to put the city in even the condition that it was before! The sum of these figures represents the cost of that fire, to counterbalance which the people may receive the paltry sum of £24,500,000 from the insurance companies.

"Merely by way of illustration of the imbecility of poor construction, it is well to note that had £2,000,000 more been spent originally in sane provisions against fire it would have reduced this loss at least £32,000,000—a pretty good interest on the investment. Or if the architects had had but sense enough to have spent even £120,000 more on the thirty-five so-called 'fireproof' buildings, or rather, shifted that sum from frivolous ornaments to necessary precautions—covering every particle of steel framing, for instance, with hollow fireproofing tile—they would have saved those buildings intact, buildings in which £1,800,000 or more destruction was wrought. Simpler still, had the precaution been taken of protecting the windows of those buildings with wired glass, at an additional expenditure of possibly £12,000, their interiors and contents would certainly have been saved. . . .

"Reverting again to poor San Francisco, that stricken city has shown that she has not profited over much by her severe les-

son; her new building laws are but little better than the old; the suggestion we made to widen some of her streets, thus creating fire barriers, has been scouted at—ignored. She has not enlarged her fire limits and no period has been assigned to the temporariness of her very temporary buildings, and it is only a question of time when almost as terrible a catastrophe may befall her as the ordeal through which she has just passed. All this is done with a mistaken idea of economy. Even if each individual had to put 50 per cent more into his building than he intended to, or reduced his ornamentation and frills to that extent in order to build properly, it would mean in the long run profit to himself and to the community. But many billions of property will yet have to be destroyed before we learn our lesson.

"Quite incidentally—because life is cheap with us—we have gotten to the point where nearly 7,000 lives are annually wiped out by fire, and every day in the year there are 36,000 lives directly exposed to destruction, people carried out of burning buildings, escaping to adjacent roofs, etc., etc., of whom quite a large per cent. are more or less injured.

"New York averages 'normally' 7,800 fires a year; Chicago 4,100. We burn up 3 theatres, 3 public halls, 12 churches, 10 schools, 2 hospitals, 2 asylums, 2 colleges, 6 apartment houses, 3 department stores, 2 gaols, 26 hotels, 140 flats and stores, and 1,600 homes every 'normal' week—a record of which we surely need not be proud.

"In a most exhaustive examination of the results of that horrible fire at San Francisco we found nothing that was not perfectly known to fire experts before, nothing new for us to preach about; just the same old folly of using wood where it ought not to be used, and the same mistaken zeal in applying the term 'absolutely fireproof' to buildings where structural parts only were incombustible and protected. The standard of a perfect building remains just as it was before, and we can but reiterate our advice, our prayer, even though it be in but a wail in the desert.

"A building that is of incombustible materials is not necessarily fireproof; a building that is of fireproof materials, but not of fireproof design, is not fireproof; a building that is not of fireproof construction and design, except in part, is not fireproof; a building that is strictly, thoroughly fireproof, filled with combustible contents, may have a destructive fire in some one of its parts, but the building itself will not be wrecked or destroyed, and if the units are properly separated and protected, the floors absolutely isolated one from the other, the greater part of that building's contents is safe. . . .

"In such a building, and in such an one only, is there absolute immunity from destruction by fire. The tenants' property can only suffer from insignificant local blaze. Their interests are best safeguarded in such a structure, and, in turn, the owner has a permanent, non-damageable investment. Such a building is not an unattainable affair. To do all these things well entails skill on the part of the designer, true; but even the first cost of construction is surprisingly little more than that of the most flimsy affairs. The surprise, the astounding thing about it all, is that in this great and prosperous country of ours there are not twenty such buildings!"

INTERNAL-COMBUSTION ENGINES FOR MARINE PURPOSES.

A DISCUSSION OF THE POSSIBILITIES OF THE GAS ENGINE FOR THE PROPULSION OF LARGE SHIPS.

J. T. Milton—Institution of Civil Engineers.

ALTHOUGH the internal-combustion engine has been successfully employed in small vessels and motor boats, the difficulties in the way of its application to the propulsion of large vessels have proved too great to be overcome in the present stage of advancement of the large gas engine and of the gas producer. The perfecting of a large marine gas engine would, however, make possible a reduction in coal consumption of about one-half and the importance of the subject can hardly be exaggerated. The latest contribution to the discussion is contained in

a paper by Mr. J. T. Milton, recently read before the Institution of Civil Engineers, which discusses the essential features of the successful marine engine and the mechanical arrangement of the gas engine most likely to give satisfactory results..

Mr. Milton states that the economy and the increasing use of internal-combustion engines on land has led to considerable interest being taken in their application to marine purposes, and that already a large number of such engines have been fitted in small craft on the Continent, in most of which heavy mineral oil is the fuel used. On land, various fuels are used for these engines, namely, petrol, refined oil, heavy oil, coal-gas, producer-gas, coke-oven gas, and blast-furnace gas, but for marine purposes generally producer-gas and heavy oil are at present the only available fuels. In this paper, however, the question of fuel is not dealt with, only the mechanism and arrangement of the engine being discussed.

It is pointed out that very large engines are in use on land, and that the experience of details necessary to make the large cylinders capable of withstanding the shocks of explosion and the high temperatures of the burning fuel will be available for marine engines, if the other necessary mechanical requirements are complied with.

The special conditions required for a successful marine engine are:—

(*a*) The engine must be reversible;

(*b*) It must be capable of being quickly stopped, and of being quickly started, either ahead or astern;

(*c*) It must be capable of being promptly speeded to any desired point between full speed and dead slow, which latter speed ought not to be greater than one-quarter of the full speed;

(*d*) It must be capable of working well, not only in smooth water, but in heavy weather in a seaway in which the varying immersion of the propeller causes rapidly-changing conditions of resistance.

In large engines these conditions prohibit the use of movable-bladed propellers, clutches, and toothed gearing, and also of a fly-wheel, and necessitate the use of a reversing engine with a direct drive on to a fixed propeller, and they require also a fairly equable turning-moment at all working speeds.

In marine engines the revolutions are practically proportional to the speed of the ship, and as the vessel's resistance increases much more rapidly than the speed, it follows that for a reduction of speed of revolution the mean effective pressure must be reduced much more than in proportion to the revolutions. This is a much more difficult problem in marine engines, where no fly-wheel is practicable, than on land, where the use of a heavy fly-wheel permits the suppression of alternate fuel-charges.

The question of the turning-moment of the engine receives consideration. With the four-stroke cycle, where one single-acting cylinder only is employed, the fluctuation of moment varies from 7.7 times the mean moment in a forward direction to 1.5 times the mean moment in the reverse way. With two such cylinders, or with one double-acting cylinder, the motion is better, but is still unsuitable, and the minimum number of cylinders which will always give a positive turning-moment is four single-acting or two double-acting.

Diagrams are shown of the turning-moments resulting from a vertical two-cylinder tandem engine with one crank; also of three such engines working on one crank-shaft with the cranks at equal angles, and of four such engines with cranks at equal angles, and at intermediate positions, and the inference is drawn that the arrangement with three cranks is, on the whole, preferable for marine work. Such an engine, however, working on the four-stroke cycle will not give the range of low speed necessary for marine work.

The question of carrying out the compression and expansion in separate cylinders is next considered. It is pointed out that if this is done the compression-cylinders are not subjected to the very high pressures and high temperatures produced by ignition, but, on the other hand, there is considerably more work performed in the compression-cylinders, as the gas has not only to be compressed, but also to be forced out of the cylinders. The extra work necessary for this may, however, for the most part, be returned by making the expansion-cylinder with a minimum of clearance, and arranging for the admitted charge by its pressure to force the piston some part of the stroke before ignition. By

this arrangement separate compression and expansion could be arranged for without much loss of economy.

The arrangement permits of other advantages. As the clearance is minimized, there is practically no burnt gas left in the cylinder to unduly dilute the charge. The mean pressure can therefore be reduced in two ways—(1) by diluting the charge with excess of air down to the lowest firing proportion; and (2) by throttling the supply. It may also be possible to arrange for an earlier cut-off. Altogether the arrangement will permit a much lower mean pressure to be obtained than is possible with the four-stroke cycle. Further, by admitting only compressed air suitably throttled, the engine will work at very low speeds, in the same way that a steam-engine will work when throttled. An incidental advantage is the complete suppression of the two-to-one gear.

An installation which Mr. Milton thinks would be suitable for marine purposes consists of an independent main engine driving the screw, having three double-acting expansion cylinders with three cranks set at equal angles. The compression is proposed to be effected by a separate engine without reversing-gear, having two sets of tandem engines, four cylinders in all, working on the four-stroke cycle driving two-stage air- and gas-compressors. The compressors would deliver into storage-receivers, from which the main engine would receive its charge.

THE VIENNA-BADEN ALTERNATING-CURRENT ELECTRIC ROAD.

AN INTERURBAN LINE OPERATING WITH DIRECT CURRENT OVER CITY TRAMWAY SECTIONS.

Elektrotechnische Zeitshcrift.

WHILE the question of the relative advantages of direct and alternating current for standard heavy railroad service is in an unsettled and transitory state, owing to lack of actual experience from which to draw conclusions of value for either the mechanical or the operating department of a railroad, yet, for lines of light traffic and particularly for interurban roads, the use of the alternating current, supplying power to "compensated" motors, is certainly increasing in the United States. This system has been adopted as a result of the development of a motor adapted to either direct or alternating current, and upon realizing that for long lines the saving in copper effected by the use of medium high pressure alternating current more than compensated for a lower efficiency of the motor as compared with the direct-current motor. In Europe, the principal application of electricity to railways, excepting the tramways in cities, has been to isolated lines like the mountain railways of Switzerland and other countries, where, as a rule, three-phase current appears to have given the best results. Such lines as the Valtellina of Italy, the Stansstad-Engelberg line, and the Jungfrau railway of Switzerland are so equipped; and in these cases, the conditions are best suited to the use of such a system, as these lines have to deal only with the movement of cars on their own particular rails. On the other hand, the development of interurban electric lines, in the sense in which we understand that term—namely, a line from the business center of one city to that of another, and carrying local passengers like any tramway at each end, and through passengers on express schedules between termini—this sort of line is as yet not much developed in Europe. In the United States conditions of traffic and distribution of population differ from those of Europe, but lately, in some cases, the use of single-phase alternating current has been seriously considered for just such roads as those cited above, on at least one of which the American type of compensated series motor, adapted for either alternating or direct current, has been installed and is now said to be giving satisfaction.

The railway between Vienna and Baden (Austria), has been equipped to operate electric trains or single cars, and a recent issue of the *Elektrotechnische Zeitschrift* contained an excellent illustrated description of the cars now in use for passenger traffic. The line is about sixteen miles in

length, and the cars run on the tracks of the local tramway in each city. Under these circumstances, it was considered best to adopt alternating current for the strictly interurban portion of the road, and a motor that would work with equal facility on either that current or the direct current of the Baden or Vienna tramways, thus giving satisfactory operating results as well as a line construction that would reduce the cost of copper somewhat. An overhead wire is installed, and the current collected by sliding trolleys. The cars are mounted on four-wheel trucks, spaced 19 feet 8 inches center to center, the bodies have platforms with enclosed vestibules entered through double swinging doors at the sides, and the roof is built with a clearstory and sloping ends closely resembling American designs. Inside, the seats are placed transversely on either side of a center aisle, and are of the turnover pattern. The cars accommodate 44 passengers.

On each truck of the car two 40 horsepower motors are placed, which drive the 34-inch wheels through single reduction gears. The wheel base of each truck is 6 feet, affording ample room for the motors. As mentioned before, single-phase alternating current is supplied, and the motors are built with a compensating winding to adapt them to it, as well as a commutator, which of course would be an essential feature for their direct-current operation. The current-collecting device consists of two aluminum sliders about 33 inches long, set transversely to the trolley wire and having a convex upper surface that insures long life and good contact. They are supported on a frame of pantagraph construction, built so as to allow the great flexibility needed on various portions of the line where it passes under low bridges and in other situations where the trolley wire is unusually high above the track. An extreme vertical range of 5 feet 8 inches is afforded by this particular arrangement. The operation of the motors is accomplished through a series-parallel controller, and the connections are so made that no trouble or delay ensues when the current supply changes from direct to alternating, or vice versa. The motors are said to give entire satisfaction. When operating on direct-current with the two pairs of motors in series, and 125 volts available at the terminals of each motor, a speed of 9.3 miles per hour was maintained on a 15 per cent grade, the car hauling a trailer, which with the motor car, weighed 68 tons. Using alternating current, with 250 volts at each motor, the speed with the same load was 25 miles per hour on a 7 per cent grade; while on a grade just half this, or 3½ per cent and raising the voltage to 300 per motor, the same load was pulled at 38 miles per hour. The motors have a very slight heating effect, the ventilation being good and plenty of air channels being provided. The cars are equipped with the vacuum brake, operated by a motor-driven pump. They are lighted by twenty 16 candle-power 60-volt incandescent lamps, and warmed by Prometheus electric heaters, the circuits for these being carried between motor and trailer cars by cables.

With the opportunity afforded by a location of this kind near Vienna, it is perhaps a little surprising that high-pressure alternating current was not used. Possibly local regulations prevented, but there was certainly a saving in copper to be effected by its use. With a high alternating-current voltage, of course the motor car must carry a correspondingly large step-down transformer, increasing the dead weight of the car; but up to a certain point this need not be objectionable considering the excellent construction of modern cars and the solidity of track and roadbed on European lines. While in the published description the alternating-current voltage is not mentioned, it is evidently less than 1,000 volts, and it would appear to have been productive of better results to raise this to 2,500 or 3,000 volts, adopt catenary construction for the overhead wire, and build the car strong enough to carry the necessary transformer. While there is still, in some parts of Europe, that spirit of conservatism that hesitates to adopt designs involving novel features or devices recently put in service, still the progress made during the last few years indicates that foreign engineers are, as a body, exceedingly alive to the reception of new ideas and to the prompt development of anything likely to be of value. It is not likely to be long, therefore, before high-voltage alternating-current traction systems are as common in Europe as in America.

BOILER INSTALLATION AT THE NUREMBERG EXPOSITION.

A NOVEL TYPE OF CONTINENTAL INSTALLATION SHOWN AMONG MORE FAMILIAR DESIGNS.

J. Schmidt—Elektrotechnik und Maschinenbau.

FOR furnishing steam in the power plant at the Centennial Jubilee Exposition of Bavaria, held last summer at Nuremberg, six boilers were installed, five of the water-tube type, and one a modified fire-tube boiler. While resembling American practice in many respects, the installation considered as an exhibit displayed a variety of detail design and is interesting as showing the trend of boiler development on the Continent. One boiler shown was, to say the least, unusual, but no doubt has certain features to recommend it. Recent issues of *Elektrotechnik und Maschinenbau* contained illustrated descriptions of these steam generators, from which we abstract a few particulars. Three different establishments furnished examples of their work—Dürr & Co., Ratigen, built three boilers, Jaques Piedboef, Rachen, two, and the German Babcock & Wilcox Company of Oberhausen, one. The combined capacity of the six generators is 66,000 pounds steam per hour at 176-pound pressure and 300 degrees Cent. superheat. Steam is utilized in nine engines of various types of a total of 3,100 horse power, driving generators for light and power all through the exposition.

Of the three Dürr boilers exhibited, two are called stationary or "land boilers," and one is designed for marine use. They all have inclined water tubes and a transverse steam drum, in addition to which they are equipped with superheater tubes. Chain grates are used and the stationary boilers have 72 square feet of grate surface, 1,943 square feet of heating surface, and 990 square feet area in the superheater. The ratios for the marine boiler are somewhat different, it having only 55 square feet grate area to 2,155 square feet of heating surface, with 136 square feet additional in the superheater. The requirements of marine service impose a more compact design in this boiler than need be considered in stationary work, with the result that less floor space is occupied by the marine type, but the additional height required causes some difference in the arrangement and spacing of the tubes. A distinctive feature of construction of these generators is the arrangement of inner water tubes to promote circulation. The upper, or back end of the inclined water tubes terminates in one large header or chamber, which has a vertical partition dividing it into front and back water chambers. The main water tubes, directly exposed to the fire, communicate with the inner chamber, and each one has inside of it a tube of smaller diameter, open at the lower end, which, passing through the partition in the header, opens into the outer chamber of it. The currents of steam produced are upwards in the outer tubes and downwards in the inner ones. This should insure good circulation, but might give some trouble if a water rich in scale-forming ingredients were used. The superheaters used with these boilers are quite large in proportion to the tube-heating area, as they must be for the conditions imposed. The superheater tubes are transverse. The "land" boilers have in addition a fuel economizer so arranged that the smoke and gases may be passed around the economizer tubes or directly discharged to the chimney.

A good example of modern steam practice is the boiler built by Piedboef, with inclined water tubes which communicate at each end with a water chamber, from which tubes lead to two horizontal steam drums, these closely resembling the Babcock & Wilcox design, but differing from it in the much greater vertical separation of the water tubes and steam-collecting drum of the German model. In the latter, the object of this separation is to make room for a deep firebrick arch, causing the fire to take an upward and then forward course directly over and around the superheater tubes placed transversely over the arch and under the two steam drums. This superheater has 1,022 square feet area, while the total heating surface of the boiler not including superheater is 3,240 square feet. The use of flat plate surfaces forming the

walls of the water chambers at the upper and lower ends of the tubes would seem to be an element of weakness in this design as compared with those having small headers arranged in groups, which give greater safety from disastrous rupture and afford accessibility for making repairs and cleaning. The feed pipes are carried in near the bottom of the steam drums and to a point at least one-third the length of the drum from the end at which the pipes enter, thus facilitating circulation. The other product of the Piedboef establishment, called a "combination boiler," is decidedly novel in design and may be described as a double cylindrical boiler, with corrugated flues in the lower and tubes in the upper half. It consists of two cylindrical steam generators, one above the other, the lower being 22 feet 4 inches long by 8 feet 2 inches diameter, and having three corrugated flues 31 inches in diameter, traversing it from end to end. The smoke and gases from these three furnaces pass into a chamber in which the superheater tubes are located, thence backwards through the tubes in the upper cylinder, thence to the uptake and chimney. This upper cylinder is 8 feet 2 inches in diameter and 16 feet 5 inches long, with 148 3¼-inch tubes. The two cylindrical portions of the boiler are in communication with each other through a tube 28 inches in diameter, and in normal working, the lower part is filled with water, and in the upper the water level is maintained 26 inches above the center line. A superheater is installed, consisting of eight sets of tubes connected to a header, and furnishing 334 square feet of heating surface, in addition to the 3,260 square feet of heating area in the flues and tubes. The upper part of the boiler has a dome from which the connection to the superheater is taken off. In proportion to its size and area of heating surface, the steam room of this boiler seems very limited, though this disadvantage is minimized by the use of a superheater. The three furnaces furnish means of applying heat in an efficient manner, yet the division of the boiler into two parts seems only a useless complication. Conditions are so different in Continental and in Western countries that any criticism to be just, must consider the particular kind of plant in which any boiler is to be installed, and no doubt this particular one represents truly the best for certain specific installations.

The sixth boiler of the Exposition plant is a German Babcock & Wilcox, closely resembling the American type so well-known. It has a total heating surface of 3,874 square feet, and 75 square feet of grate area. Its general features are so well understood as to call for little comment here. The 180 4-inch water tubes are arranged in eighteen vertical staggered rows, 10 tubes comprising each vertical row, and set at each end in the Babcock & Wilcox headers with connections to the twin steam drums. The superheater, located between drums and tubes, has 452 square feet of surface. All the foregoing boilers are equipped with some form of chain grate or mechanical stoker and in this respect present no particular feature of interest.

STEAM TURBINES AT THE NUREMBERG EXPOSITION.

TWO-THIRDS OF THE POWER PLANT REPRESENTED BY TURBINES OF THREE LEADING TYPES.

C. W. Gesell—Zeitschrift für das Gesamte Turbinenwesen.

DR. C. W. Gesell, writing an article descriptive of the turbines exhibited at Nuremberg last summer, classifies them as of three types:

1. Direct-acting, wherein the potential energy of the steam is transformed directly.

2. Reaction system, by which the energy transformation is accomplished through the reaction of the steam through the leading and moving portions.

3. The combined action and reaction system.

Of the first class, a Zoelly turbine of 700 horse power was shown. It runs at 2,500 revolutions a minute and is direct-connected to a 250-volt direct-current dynamo. This turbine has nine disks or movable pieces, the steam being distributed along the inner shell of the housing through a passage of increasing area. This turbine is set hori-

zontally, as are all those exhibited (none of the Curtis type being shown), and with the generator, which rests on a bedplate common to both, occupies a floor space 23 feet 9 inches by 6 feet 3 inches.

It has a surface condenser, independently driven, with 2,774 square feet area of cooling surface. A centrifugal pump supplies the condensing water. Both it and the air pump are operated by a 35 horse-power direct-current motor through gears.

Another turbine, built on the same principle, by the Nuremberg works, is of 200 horse power and direct-coupled to a 550-volt direct-current dynamo running at 2,500 revolutions per minute. The steam expands through ten nozzles, and transforms its potential energy in three stages. This turbine is provided with a jet condenser.

A boiler with a turbo-generator unit mounted on it was a feature of the exhibit. A cylindrical boiler with 302 square feet of heating surface, with a corrugated-flue furnace, furnishes steam at 176-pound pressure to the 50 horse-power turbo-generator set mounted on it and running at 5,000 revolutions per minute. One end of the turbine shaft is coupled to the shaft of the dynamo, while the other carries a pinion meshing into a gear on the shaft of which a belt pulley is mounted. The gear ratio is 50:8, thus affording a considerable range of application for this self-contained power plant. The coal is fed into a hopper over a chain grate, driven by a small electric motor. It is also equipped with a superheater of the Hering type, giving 400 degrees Cent. superheat.

A reaction-type turbine of 45 horse power, and similar to the Parsons, was also exhibited.

The most powerful turbine shown was the Sulzer, of 1,200 horse power, running at 1,500 revolutions per minute and direct-connected to a 3,000-volt alternating-current generator. This is of the combined action and reaction type, designed to combine the advantage of other kinds, and giving the highest temperature and highest pressure, and utilizing the greatest degree of expansion of the steam. The wheels are Siemens-Martin steel, with blades made of 25 per cent nickel steel, stamped and pressed.

In all these turbines, forced lubrication was used for the thrust bearings. In conclusion, it is interesting to note that of the entire power plant at the Exposition, amounting in all to 3,200 horse power, steam turbines were supplying about two-thirds of the total, or 2,195 horse power.

REINFORCED CONCRETE ON THE CONTINENT.

RECENT EXAMPLES OF ITS USE IN BRIDGE AND SEA-WALL CONSTRUCTION.

Beton und Eisen.

FOREIGN engineers have not been slow to take advantage of the facilities offered by reinforced concrete in the construction of a great variety of structures, and recent issues of "Beton und Eisen" have contained several articles descriptive of railway and other works undertaken and completed during the last year. In France, the adoption of this material for railway structures has not been so rapid as for other kinds of work, but at Gennevilliers, not far from Paris, a viaduct has been put up carrying the tracks of the Northern Railroad of France, and consisting of a bridge and a viaduct approaching it from each end. The viaduct is supported on columns of rectangular section, viaduct and columns alike being made of reinforced concrete. The bridge just referred to is of 52-feet 6-inches span, and rests on masonry abutments. It is designed for a moving load made up of trains of coal cars weighing 127,600 pounds on a 31-feet 6-inches wheel base. This is a standard type of double-bogie coal car used on the Northern railroad, and the locomotive load is based upon a total weight of 110,000 pounds on a wheel base of 12-feet 8-inches. The total length of the structure is 375 feet 6 inches, and the viaduct varies in width from 17 feet 3 inches to 41 feet 4 inches. The allowance made for wind pressure on the vertical exposed surfaces is 134.2 pounds per square foot, while on

flat horizontal portions of the structure the wind effect and the maximum possible weight of snow has been figured out on a basis of 33.6 pounds per square foot. The bridge and viaduct are a solid, substantial looking work, but the necessities of this particular case make it impossible to beautify it in any way since the idea of low first cost has been rigidly adhered to.

Of quite different character, is a lately built bridge at the railway station in Lausanne, Switzerland, carrying the city roadway and approach to the station over the railway tracks. The structure is supported by piers spaced about 32 feet center to center, and though designed on simple lines, is very pleasing to the eye, especially considering its location and use. The bridge has a roadway 23 feet wide, with a sidewalk on either side 4 feet 11 inches in width. It is designed to carry a load of 504 pounds per square foot on the roadway. Static tests have shown that with this load, applied by means of piles of rails, there was a deflection of from 0.028 to 0.033 inch.

In Holland, a sea-wall has been undertaken as a protection for the sand dunes from the action of the sea on the coast of Zeeland. The concrete was formed into an embankment with a slope corresponding to that of the sand, and the outer surface is provided with transverse ribs running down from the base of the wall proper, and about 7 feet apart from one another. The wall itself is prismatic in section, 3 feet 6 inches high, and practically forms the crest of the dike that protects the land from the inroads of the sea. A particularly severe storm on March 12, 1906, caused so much damage to the shore that it was determined to strengthen the exposed front by the means described.

ENGINEERING EDUCATION.

THE NATURE AND METHOD OF INSTRUCTION BEST CALCULATED TO PRODUCE THE ESSENTIAL CHARACTERISTICS OF THE SUCCESSFUL ELECTRICAL ENGINEER.

B. A. Behrend—Electrical World.

NOTWITHSTANDING the attention that has been paid to the question of technical education since the present period of industrial activity began, it is a matter of general complaint that the results are not satisfactory. The expenditure of immense sums of money on palatial buildings, complete equipments, and an army of instructors, has so signally failed to produce the type of young engineer required by the present conditions of the manufacturing industry, that it was stated in an address recently reviewed in these columns, that not until at least two years after graduation does the average technical graduate begin to be of use to his employer. On account of his experience as a student in German universities, as a teacher in several technical institutions in the United States and Canada, and as chief engineer of a company which employs large numbers of technical graduates, the views advanced by Mr. B. A. Behrend in a recent number of the *Electrical World* are an interesting and valuable addition to the discussion of this important subject.

Mr. Behrend prefaces his article with a quotation from one of Huxley's addresses. Speaking to an audience of medical students, Huxley remarked that one of the striking characteristics of most medical men, was the "singular unreality" of their knowledge of medicine; "what he had looked for was a real, precise, thorough and practical knowledge of fundamentals; whereas that which the best of the candidates, in a large proportion of cases, have had to give, was a large, extensive, and inaccurate knowledge of superstructure." Mr. Behrend considers that Huxley's statement with regard to medical students of thirty years ago applies singularly well to engineering students of today. The three elements which enter into education are, first of all the teacher, secondly the student, and last and least the school.

"We must have good, competent teachers, and there can be no doubt that such good, competent teachers can be obtained and that a great many universities, both in Europe and in this country, already possess them. The inspiration which students obtain from great masters in their professions, is infinitely greater than the benefit

which will come to them from having studied in palatial buildings, built by, and dedicated to, men who have been favored by fortune in the great struggle for wealth, which well nigh obscures today the engineering side of industry. . . . It seems to be commonly assumed by those who have never done much scientific or engineering work themselves, that it is the building and equipment which are the essential features of, and the foundation for, good engineering education. Poor workmen always quarrel with their tools; poor teachers naturally quarrel with their equipment. . . . In this connection it may not be amiss to mention that some of the greatest experimental discoveries in natural science have been made in laboratories which were poorly equipped, even considering the time when these discoveries were made. I have merely to mention the experimental researches of Michael Faraday and the remarkable achievements of Justus Liebig to make us realise that there is no proportionality between the equipment and the discovery. Some of the great achievements of modern science have been made in laboratories which were by no means equipped in a remarkable way. The researches on electric waves by Heinrich Hertz and the work of Rutherford were carried out in laboratories which, from the modern standpoint, were anything but complete in their equipment."

There is a tendency both in America and Europe to build palatial universities instead of plain dignified structures and the acceptance of such gifts places the university under obligations to their munificent donors. One of the disadvantages of this is, that the necessity for large sums of money for the maintenance of such institutions prevents freedom of thought or at least of speech on the part of their officials; but the greatest disadvantage lies in the fact that the sums remaining after the endowment of these buildings are usually much too small to provide for competent teaching. It is quite true that teachers should set an example of simplicity to their students. "But it is disregarding all common sense, and also the realities of life to expect to be able to obtain the services of a man qualified to instruct and direct younger men in a difficult scientific profession, to work away all his life on a salary which hardly enables him to give his children careful education and to save for his old age. It has thus come to pass that men who have been shipwrecked in their professions in life have sought a haven in teaching. More and more, the educators of Europe begin to realise the necessity of employing the highest talent obtainable in scientific teaching; and . . . some of the most eminent engineers have been called to chairs in the technical college, in which positions they have the opportunity of still practicing their professions, and yet giving the younger generation the benefit of their wide experience and knowledge."

Mr. Behrend then outlines the history of the gradual withdrawal of the teaching of applied science from the university and the development of the technical institute, and the subsequent gradual return of the latter, particularly in America, to the old form of university organization.

Despite the inroad of "commercialism" into engineering, there are at the present time, opportunities for the application of engineering ability that have never been equalled, on account of the fact that continual improvement in product is essential to success in the manufacturing business. This element of so-called "commercialism" makes it all the more necessary that the engineer should be possessed of a strong and determined character. On account of the keenness of competition, demands will be made upon him for cheaper machinery and it will be necessary for him to offer strong and continued opposition to the opinions of those who lack the insight and experience, the knowledge and ability to weigh difficult and responsible engineering problems.

"The matter of greatest importance which I have endeavored to bring out and upon which I wish to dwell particularly, is the necessity of engaging the most eminent engineers as teachers. This can readily be done if they are granted enough time still to continue their professions. It should then be left to these men to train their associate professors and instructors whose entire time should be devoted to the supervision of the students. This one step would work a revolution in the methods of teaching. By thus closely bringing together

the man who teaches pure mathematics, abstract dynamics, and abstract physics, with the practical engineer, both will profit considerably. The abstract teacher will obtain examples for his students from the practical man and, conversely, the practical man will remain in touch with pure theory. The practical engineer will insist upon the students learning to draw, to sketch and to work out problems in a thorough and responsible manner. If there is any one defect more obvious than another in the training of the graduate students, it is the utter failure to appreciate the seriousness of responsibility down to the slightest detail. Their handwriting is illegible; their figures are confused; their sevens look like their twos; they cannot letter; they cannot draw; they cannot count the speed of a motor accurately; and all these things do not seem to have been even impressed upon them as being of importance. . . . Most of the manufacturing concerns have been obliged to institute regular training schools for these young men in which it is the endeavor of the instructing engineer to make the young men unlearn much that they have learned so as to make them receptive for our methods. . . .

"The more theory in college the better! The students cannot receive good practical instruction in college, hence let them get as much theoretical training as possible. Mechanical laboratories are very well and better than football, but they do not at all take the place of a year's training in a shop. It is customary in Europe that engineering students work for at least one year in a shop before entering college, and this seems to me preferable to our custom of allowing the students to work in the shop after graduation. The explanation of the European system is that the engineering teachers, themselves practical men, have found it difficult to teach young men who have had no shop training. The more shop training the better. It is foolish to have young men design apparatus which nobody can build rationally with the tools and the machinery at the disposal of a large manufacturing plant. Let the high-school graduate work in a machine shop, according to his ability and inclination, for one or two years, and let him be thrown into contact with working men, their methods and their lives. It will do him good in his future work and it will show him how easy it is to make a drawing, and how difficult it is to build the apparatus according to such drawing. He will become thoroughly awake to the problems which the practical man has to solve and he will be a much better and brighter student in college, keenly appreciating the tremendous assistance rendered him by sound theory. . . .

"I have alluded in passing in this paper to the necessity of a sound moral training in the young engineer. Having entered life, he will be confronted with temptation at every step. To cheapen his designs, he will be tempted to use poor materials leading to disastrous results; he will be tempted to make better guarantees than he can obtain, owing to the pressure from competition; and most abject of all, his influence will be coveted for the obtaining of large contracts in the letting of which he has a voice. Such crimes will be more flagrant in him than in the ordinary business man. The latter cannot plead the inspiration and the example of the men of science, to whom we owe the sources of our knowledge. There can be no better foundation laid in the minds of these young enginers than is given them by the example of the long line of brilliant scientific men who, like noble ancestors, should inspire them with the dignity and grandeur of their profession. Let them read the lives of great scientific men; let them admire the keen intellect and the devotion to scientific work of Galileo, of Leonardo da Vinci, of Newton, of Faraday, of Helmholtz, of Kelvin and of Huxley. Let them emulate the example of great engineers like Siemens, Rankine, Hopkinson, Bell, and other great men whose lives are an inspiration, and they will be steeled against the perverting temptations of their profession."

"Mr. Andrew D. White, co-founder and first president of Cornell University, that great American institution of learning which stands out as the first university in this country, in which the teachers were chosen without regard to sectarian leanings, said once that 'our great disease is indifference—indifference to truth as truth, and the little army of scientific men furnishes a precious germ from which better ideas may spring, and,' the great educator

proceeds, 'we should strengthen them. We have already multitudes of foundations of appliances for the dilution of truth—for the stunting of truth—for the promotion of half-truths—for the development of this or that side of truth. We have no end of intellectual hothouse arrangements for the cultivation of the plausible rather than the true; and therefore it is that we ought to attach vast value to the men who, with calmness and determination seek THE TRUTH, in its wholeness, on whatever line of investigation, not diluting it or masking it. Their zeal, their devotion, their faith, furnish one of those very protests which are most needed against that low tone of political ideas which, in its lower strata, is political corruption. Their life gives that very example of a high spirit, aim, and work, which the time so greatly needs!'"

THE ETHICS OF TRADE SECRETS.

THE RELATION OF TRADE SECRETS TO PATENTS AND THE LEGAL PROTECTION OFFERED THEIR POSSESSORS.

F. P. Fish—American Society of Mechanical Engineers.

THE protection of trade secrets has never been made, either in England or in America, the subject of actual statutory provisions. Patents, on the other hand, have been the subject of considerable legislation and laws relating to them are being continually revised and improved. The possessor of the trade secret has therefore to depend for protection upon certain fundamental principles of the common law. An interesting discussion of these principles and of the relation of trade secrets to patents is contained in an address recently delivered by Frederick P. Fish before the American Society of Mechanical Engineers. The information contained in this address is of especial interest when read in connection with Mr. Prindle's articles on patents in recent numbers of this magazine.

It is not until a nation has reached a comparatively high stage in its development, that its jurisprudence begins to turn from the consideration of personal rights and tangible properties to that of such intangible properties as patents, copyright and trade secrets; and it is only within the last hundred years that the trade secret has been recognized in common law. Its history has, however, been a long one: for in all ages, trade secrets have been in the possession of individuals and guilds. Their possessors made every effort to preserve them; and those who did not know the secrets sought to learn them. "It seems clear that the right to preserve a trade secret if one could, and to an equal degree the right to get the secret of another by any means not offensive to the moral sense, were always recognized"; and kings and governments often acted on this principle in the absence of definite laws. With the development of individual enterprise in the trades, trade secrets came to be regarded as substantial things. Further, "It has been generally recognized that the gain to the community would be the greatest if every member of it was stimulated to do his utmost for himself. . . . It does not seem possible to deny that the general sentiment has almost always been in favor of the encouragement of the individual in his selfish aspirations for personal prosperity." These are the fundamental principles in the common law recognition of the right of trade secrets to protection.

"For all practical purposes, the views of the courts are based upon a single and simple proposition. An individual is justly and honestly in possession of what is a real trade secret, that is, something useful in his business that is known to him and protected by him to the extent of his power as a secret of his trade. There seems no doubt that this is a real property interest exactly as an invention is property to such an extent that the government can make a contract with reference to it by which it is protected for a limited term by a patent, and exactly as an artistic or literary expression is protected as property. But in any event, it is obviously unfair that those who have entered into a fiduciary relationship with the possessor of the secret, or who by express contract or by a consideration of the relationship must necessarily be said to have assented to an implied contract to protect the secret, should undertake to rob the owner of his secret by communi-

cating it to others or using it themselves. In a large number of the cases that have been before the courts, there has been no express agreement to protect the trade secret. There has been held to be, however, a necessary implication that such an agreement existed because of the relation of service. . . .

"It is just to this extent and no further that trade secrets are protected. The law does not intervene to protect the secret against discovery by fair and honest means. It does not undertake to make the secret, as such, secure. It only enables it to be utilized, for the good of the possessor and of the public, without danger of betrayal by those who must necessarily learn the secret in confidence while it is being operated as a secret, and who can betray it only by what the law regards as a breach of honesty and fair dealing. . . .

"It is well settled that the alleged secret must be a real secret. I believe, however, that before the courts should intervene to protect an alleged trade secret it should appear that it was not only regarded as secret, but that it was distinctly treated carefully as such and guarded by the possessor of it. It should not be enough that he has had it in mind to call it a trade secret, if he ever needed to invoke the protection of the law. He must have taken all necessary and reasonable precautions to prevent its disclosure. Moreover, it does not seem proper that he should have redress against his employés and associates unless it is made to appear that they knew, while occupying the fiduciary relation which gave them the opportunity to learn the secret, that the specific thing now called a secret was in fact regarded and treated as a secret. It should not be enough that one man has worked for another. The employé has a perfect right to grow with his experience. He has a right to carry away for general use everything that he learns in his place or employment, except trade secrets. The public interest requires this as much as it requires that trade secrets should be respected. The employé or associate should be notified of the exact trade secret, that he may know what results of his experience he can and what he can not take away and use freely. . . .

"The whole law of patents implies the right of a man to keep as a secret that industrial improvement which he has conceived. It is because that right is recognized that patent laws exist." Instead of a constant struggle to preserve a trade secret, they offer to the inventor an absolute monopoly of the use of his invention for a certain time in exchange for the publication of his new idea. But, "there are many valid reasons why the discoverer of a new industrial process may well determine not merely that it is for his interest to take his chances of keeping it secret rather than to publish it in a patent, but that the latter course might lead to disaster. While it is generally, but not always, easy to prove an act of infringement of a patent, on a product or a tool or a machine, it is often practically impossible to obtain legal proof of the process employed by one who is believed to infringe a process patent. The infringer is very apt to be able to keep his infringement an undiscoverable secret. I am inclined to the belief that a substantial part of the important and valuable trade secrets now in use, would, if patented, be used without much, if any, chance of redress on the part of the patent owner.

"If a man elects in those few cases not to publish but to take his chances, can there be any real objection to his pursuing that course? It is certainly inconvenient and annoying to some extent. It is a real personal hardship that a workman or engineer who has learned the secret under such conditions that he must respect it, can not utilize it in his subsequent work. It undoubtedly holds back the progress of the useful arts to some extent that the whole world is not free to practice it and to improve upon it. But this, in theory, is equally true as to things that are patented, during the long term of seventeen years in which no improvement on the thing patented can be rightfully used except by the patentee or those claiming under him.

"On the other hand, I believe that sound business generally and the comparatively few arts in which such secrets are of any importance are definitely promoted by the fact that the law aids in preventing disclosures based upon bad faith on the part of an employee."

NEW INCANDESCENT LAMPS.

THE FACTORS ENTERING INTO THE PROBLEM OF PRODUCING A HIGH-EFFICIENCY INCANDESCENT LAMP.

J. Swinburne—Institution of Electrical Engineers.

DURING the past few months, these pages have contained several references to new metallic-filament incandescent lamps. A paper by Mr. J. Swinburne, recently read before the Institution of Electrical Engineers, gives an interesting summary of the factors which enter into the problem of their production.

"A little more than a quarter of a century ago several men were working out the arc lamp, and inventors were bringing out what they called semi-incandescent lamps. People's ideas were very obscure in those days, and much confusion was due to the mis-statement of the problem that was really waiting for solution.

"One of the first to understand the real nature of the problem and the proper means of solving it was Edison. He realized that high-resistance lamps could be worked in variable numbers in parallel on constant-pressure circuits. This seems so obvious now that we cannot understand where the difficulty came in; but if you will look up the technical Press just before 1880, you will find people's ideas very chaotic.

"It may seem strange that people did not experiment on some of the more refractory metals; but a little consideration will explain matters to some extent. The output of lamps was much smaller than at present, and therefore the inducement was less. Very little was known about the refractory metals, and the measurement of high melting points was more or less impossible.

"Apart from these, there was the mechanical difficulty of working up the metal into a very fine wire, and now we have to face the problem of making the wire sufficiently fine to enable the lamp to be used on circuits of 200 to 250 volts, notwithstanding low specific resistance. Squirting has made it possible to make carbon filaments as fine as desired, the difficulty now being that of mounting the filaments. If the surface emission is the same, the pressure varies directly as the square root of the cube of the length of the filament. Other things being equal, a 200 volt filament is nearly 1.56 times the length of the 100 volt conductor and about two-thirds of the diameter. It is thus very much weaker.

"But as soon as we deal with metal lamps the question of distribution comes up again. How are lamp makers to get the metal wire so fine that it will take, say, 200 volts? If a carbon lamp of 200 volts and 16 candles has an efficiency of 0.25 candles per watt, it must have a resistance of 625 ohms. But a metal lamp is made to work at, say 0.75 c.p.w., and that means that for 16 candles there are only 21.4 watts. This means a resistance of 1,870, or nearly 2,000 ohms, as compared with 625 ohms. There are two influences which help the metal lamp, however; the resistance of the metal rises considerably with the temperature, as a metal is run not very far from its softening point, and the emissivity of bright metal is less than carbon, so that to give the same light at the same efficiency the wire may be larger. It seems probable, however, that bright metal surfaces increase in emissivity as they get hot—that is to say, they get blacker as they get hotter, a black body being brighter at a given high temperature than a white body.

"We thus come upon the weak point of the metallic lamp—it is very difficult to make a small lamp of 200 volts. The questions are, therefore, whether the higher efficiency of the metal lamp will induce us to bring our pressure down to 100 volts or less, on the one hand, or whether the metal lamp can be made to take 200 volts or more either by further perfection by the use of some sort of transformer, or by using larger lamps, say, 50 candles each. ..... The metal lamps may get a certain footing on 100 volt circuits. It seems probable, however, that people's ideas of the value of light will alter, and that incandescent gas or large metal lamps will soon lead them to use 50 candles as the normal light at each point. At the same time, the ingenuity which has made metal lamps possible seems quite capable of making 200 volt 16 c.p. lamps within reasonable time."

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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BRIDGES.

Blackfriars.

The Widening of Blackfriars Bridge. Drawings and description of proposed work on this bridge across the Thames River, to afford space for a double line of electric conduit tramways. 1000 w. Engng—Jan. 18, 1907. No. 81997 A.

Brooklyn.

Enlarging the Manhattan Terminal of the Brooklyn Bridge. Gives plans adopted for the improvement of this terminal which it is believed will solve the problem due to congested traffic. Also editorial reviewing the past history and showing the enormous increase in traffic. 4000 w. Eng News—Jan. 31, 1907. No. 82030.

Concrete Arch.

The Piney Creek Bridge, Washington, D. C. Illustrates and describes the construction of this concrete arch bridge, 272 ft. long, 25 ft. wide, and about 50 ft. from the surface of the water. 1800

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w. Eng Rec—Jan. 26, 1907. No. 81946.

The Walnut Lane Concrete Arch Bridge Across the Wissahickon, Philadelphia. Illustration, drawings, and description of a beautiful concrete bridge designed to carry highway traffic. 2200 w. Eng News—Jan. 31, 1907. No. 82019.

Quebec.

Erection Attachments for Bottom Chords and Vertical Posts of the Quebec Bridge. Illustrates and describes arrangements for handling and assembling the members, showing their efficiency in securing rapidity in erection. 2300 w. Eng Rec—Jan. 19, 1907. No. 81722.

Erection of the Main Vertical Posts of the Quebec Bridge. Illustrated description of one of the most difficult operations in building this span, the erection of these posts, which, with the bracing between them make a vent nearly 415 ft. high by 75 ft. wide over all, on the center line of the main pier. 2500 w. Eng Rec—Jan. 26, 1907. No. 81948.

The Anchor Pier Towers of the Quebec Bridge. Illustrates and describes the anchor pier towers, which are 84½ ft. high and 76 ft. wide at the base. 1200 w. Eng Rec—Jan. 12, 1907. No. 81574.

Progress of the Quebec Bridge Across the St. Lawrence River. Views showing the present condition of this cantilever structure, with brief notes. 300 w. Eng News—Jan. 17, 1907. No. 81666.

The Quebec Bridge. Gives illustrations showing the progress made on this great bridge across the St. Lawrence River, describing its general features. It will contain the largest span of any type hitherto constructed. 1200 w. Engr, Lond—Jan. 18, 1907. No. 81991 A.

Reinforced Concrete.

The Design of Economic Centers for a Reinforced Concrete Arch, the Cost of Same, and the Cost of Placing the Steel and the Concrete. Gives a description of methods and cost of constructing a reinforced concrete bridge, with an economical form of centering. 2800 w. Engng-Con—Jan. 23, 1907. No. 81757.

Reinforced Concrete Railway Bridges. (Les Ponts de chemins de fer en ciment armé). Victor Forestier. Details of construction of bridges of this material recently constructed in France. Ills. 2300 w. Beton und Eisen—Nov., 1906. No. 81858 F.

Viaduct.

The George's Creek Viaduct, Southern Ry. A single-track plate girder structure about 398 ft. long and 40 ft. high, near Greenville, S. C., is illustrated and described. 500 w. Eng Rec—Jan. 12, 1907. No. 81583.

The Las Vacas Viaduct on the Guatemala Railway. A single-track 3ft. gauge structure 743 ft. long and 229 ft. high is illustrated and described in detail. 1500 w. Eng Rec—Jan. 26, 1907. No. 81951.

Reinforced Concrete Approaches and Column Footings of a Steel Viaduct at Kansas City. Kenneth Hartley. Illustrates and describes novel methods of avoiding underground obstruction. 700 w. Eng News—Jan. 31, 1907. No. 82027.

Zambesi.

Zambesi River Bridge. Illustrated description of the great steel arch on the Cape-to-Cairo railway in Africa, and the method of construction. 2000 w. Ry & Loc Engng—Jan., 1907. No. 81444 C.

CONSTRUCTION.

Borings.

See Waterways and Harbors.

Building Details.

Structural Details of the Scribner Press Building. Interesting details of a 15 story building in New York city are illustrated and described. 900 w. Eng Rec—Jan. 5, 1907. No. 81493.

Coaling Tower.

The Coaling Tower of the New Waterside Station, New York. Illustrated detailed description of arrangements for handling 300 tons of hard coal per hour, and the construction of the tower. 5600 w. Eng Rec—Jan. 19, 1907. No. 81719.

Columns.

Column Formulas in Relation to the Practical Column. An editorial discussion of column formulas and design, for the purpose of showing how a rational column theory may be grounded. 7500 w. Eng News—Jan. 3, 1907. No. 81378.

Concrete.

Forms for Concrete Construction. Sanford E. Thompson. Abstract of a paper read before the Nat. Assn. of Cement Users, giving details of form construction, and the time to remove forms. 1500 w. Eng News—Jan. 24, 1907. No. 81768.

The Treatment of Concrete Surfaces. Linn White. Abstract of a paper read before the Assn. of Cement Users. Describes some methods used in trying to obtain satisfactory surfaces in the various classes of concrete work done in South Park System of Chicago. 1800 w. Eng News—Jan. 17, 1907. No. 81671.

The Artistic Treatment of Concrete. A. O. Elzner. A discussion of the possibilities of this material from the æsthetic point of view. 2000 w. Eng Rec—Jan. 12, 1907. No. 81579.

Costs.

Cost of the Brooklyn Anchorage of the Williamsburg Bridge, New York City. Francis L. Pruyn. Gives the main items of the contract for this work and the cost of each, with explanation of methods. Ills. 2200 w. Engng-Con—Jan. 30, 1907. No. 82004.

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Dam.

Progress of Construction on the Cross River Dam. Illustrated description of construction work on the dam near Katonah, N. Y., designed to impound about nine billion gallons of water to be delivered to the city of New York. 4000 w. Eng Rec—Jan. 5, 1907. No. 81488.

The Design of the New Croton Dam. Edward Wegmann. An illustrated paper considering the design of the dam adopted for the new Croton reservoir constructed to store an additional water supply for New York City. 9800 w. Pro Am Soc of Civ Engrs—Jan., 1907. No. 81911 E.

Drainage.

Drainage of the Vrana Lowlands. (Die Entsumpfung der Niederung von Vrana). Leopold Arndt. Account of improvement works and drainage canals. Illus. 5500 w. Osterreichische Wochenschrift für das Offentlichen Baudienst—Dec. 8, 1906. No. 81841 D.

Electric Power.

Applications of Electricity in the Belmont and Pennsylvania Tunnels. Illustrates and describes applications made of electric power in the construction of these tunnels. 2800 w. Elec Wld—Jan. 12, 1907. No. 81619.

Factories.

The Structural Design of Engineering Factories. Adam Hunter. Remarks on changed conditions which have caused improvements in shops and equipment, and discusses the general principles of structural design, and some constructional details. 5800 w. Builder—Dec. 29, 1906. No. 81540 A.

Fireproof.

The Marlborough Apartment House, Baltimore, Md. Illustrated description of a ten-story building with concrete skeleton, and brick exterior walls supported on the reinforced concrete floors. 1200 w. Eng Rec—Jan. 26, 1907. No. 81950.

Foundations.

Method of Constructing the Foundations for the Trust Company of America Building. New York City. Maurice Deutsch. Illustrates and describes a typical example of foundation work in lower Manhattan Island. 2500 w. Engng-Con—Jan. 9, 1907. No. 81550.

Pneumatic Caisson Foundations. Considers the chief types of successful foundations devised in recent years, especially to meet the conditions of lower Manhattan, New York City. Gives illustrated description of the foundation work for the Singer Building. 1400 w. Archts & Bldrs' Mag—Jan., 1907. No. 81598 C.

Condensation Water Intake and Tower Foundations, New Waterside Station, New York Edison Co. Illustrates and describes the construction of the features named. 1800 w. Eng Rec—Jan. 12, 1907. No. 81581.

Irrigation.

See Water Supply.

Loading.

Methods and Costs of Loading Dump Wagons with Scrapers, and the Design of a Loading Platform. Describes work where the dump wagons were driven under a platform and loaded by drag scrapers, which were dumped through a hole in the platform. 1200 w. Engng-Con—Jan. 23, 1907. No. 81758.

Ornamental Work.

Notable Ornamental Sheet Copper Work. Illustrated description of construction work at the Hoboken terminal of the Delaware, Lackawanna & Western Railroad. 2500 w. Met Work—Jan. 5, 1906. No. 81394.

Piling.

Method and Cost of Driving Sheet Piling for the Cut-Off Wall of a Concrete Dam Founded on Sand. Carl P. Abbott. Sketch and description of method of driving, giving cost of labor, supplies, etc. 500 w. Engng-Con—Jan. 16, 1907. No. 81629.

Reclamations.

The Possibility of the Permanent Reclamation of Tulare Lake Basin, California. Charles H. Lee. Discusses the problem of the reclamation of this overflow sand. Describes the situation and conditions, and considers its reclamation feasible both from an engineering and financial standpoint. 4500 w. Eng News—Jan. 10, 1907. No. 81556.

Reinforced Concrete.

A Large Reinforced Concrete Residence. Illustrates and describes interesting features of a residence in Walkerville, Ont., of fireproof construction. 800 w. Eng Rec—Jan. 26, 1907. No. 81947.

Cost of Reinforced Concrete Building Construction. Louis H. Gibson. Estimation of cost with explanation of structural details. Ills. 1800 w. Munic Engng—Jan., 1907. No. 81385 C.

An Economical Reinforced Concrete Shop Construction. Drawings and description of work in connection with the construction of the walls of shops being erected in Plainfield, N. J. 2000 w. Eng News—Jan. 17, 1907. No. 81669.

A Reinforced-Concrete Shop with Steel Roof-Trusses and Crane-Girders. William F. Tubesing. Illustrates and describes an addition to the Bullock works of the Allis-Chalmers Co., Cincinnati, O. 1300 w. Eng News—Jan. 10, 1907. No. 81561.

The Washington Apartment House, Baltimore, Md. Brief illustrated description of a 6-story building with a reinforced concrete skeleton and floors

carrying the Indiana limestone walls at every story. 900 w. Eng Rec—Jan. 19, 1907. No. 81723.

The Collapse During Construction of a Reinforced-Concrete Building of the Eastern Kodak Co., Rochester, N. Y. Extracts from the Coroner's verdict, and from Mr. McClintock's technical report to the Coroner, with views illustrating the wreck. 3500 w. Eng News—Jan. 3, 1907. No. 81373.

The Collapse of a Reinforced Concrete Building Near Rochester, N. Y. An illustrated account of the collapse of the Kodak building. 1600 w. Eng Rec—Jan. 5, 1907. No. 81491.

Report on Failure of Reinforced Concrete Building of Eastern Kodak Co., Kodak Park, N. Y. Gives report of experts on this accident near Rochester, N. Y., after investigations made of the failure and tests of portions adjacent to the collapse. Ills. 2200 w. Eng News—Jan. 31, 1907. No. 82026.

The Calculation of Reinforced Concrete Structures with Eccentric Loading. (Die Berechnung von Eisenbeton-Konstruktionen bei Excentrisch Wirkender Normalkraft). L. Landmann. Mathematical discussion, with diagrams. Serial. 2d part. 1000 w. Beton und Eisen—Nov., 1906. No. 81860 F.

The Shearing and Crushing Resistance of Reinforced Concrete. (Die Scher- und Schubfestigkeit des Eisenbetons). Professor Mörsch. Theoretical treatment, diagrams and formulæ. 2100 w. Beton und Eisen—No., 1906. No. 81861 F.

See also Reservoirs.

Reservoirs.

The Empire Reservoir of the Bijou Irrigation District, Colorado, and its Eight Dams. Map and sections, with description of the sand chutes, and general information. 800 w. Eng News—Jan. 3, 1907. No. 81375.

The Reinforced Concrete Reservoir at Waltham, Mass. Bertram Brewer. Illustrated detailed description of the construction of this reservoir. 1500 w. Eng Rec—Jan. 12, 1907. No. 81573.

See also Stripping.

Sea Wall.

Reinforced Concrete Sea Wall (Eine Dünenverkleidung mit Armiertem Beton). R. R. L. de Muralt. Description of construction of a retaining wall on the coast of Holland. Ills. 1400 w. Beton und Eisen—Nov., 1906. No. 81859 F.

Steel-Work.

Steel-Work in the Palace Theatre, London. Illustrated description of a good example of the application of the cantilever system to this class of work. Plates. 900 w. Engng—Dec. 28, 1906. No. 81536 A.

The Keyser Building, Baltimore. A 10-story steel-cage structure of L-shape plan is illustrated and described. 1000 w. Eng Rec—Jan. 12, 1907. No. 81582.

The Condition of the Steel Work in a San Francisco Building Erected 13 Years Ago. Frank B. Gilbreth. Describes the building in detail, and reports the effect of the earthquake, and the fire, giving an illustrated description of the condition of the steel-frame and gives the conclusions from its inspection. 1800 w. Eng News—Jan. 31, 1907. No. 82023.

Stripping.

Is It Worth While to Strip the Surface Soil from Reservoir Sites? Report on Stripping the Ashokan Reservoir Site; Additional Water Supply, New York City. Full abstract of the report of Allen Hazen and George W. Fuller, with its conclusions against stripping. 6500 w. Eng News—Jan. 3, 1907. No. 81376.

Towers.

A Steel Clock Tower. Illustrates and describes details of a 160-ft. steel tower in Brooklyn. 600 w. Eng Rec—Jan. 12, 1907. No. 81576.

The Tower of the Metropolitan Life Building, New York. Illustrated description of a tower about to be erected in connection with the Home Office Building of this company. 1200 w. Eng Rec—Jan. 12, 1907. No. 81584.

The 48-story Tower of the Metropolitan Life Building, New York City. Brief description of the general system of framing, with diagrams. 600 w. Eng News—Jan. 31, 1907. No. 82028.

Tunnels.

Development of Tunneling in New York City S. D. V. Burr. Illustrates and describes work that has been accomplished beneath the city and under the rivers. 5000 w. Ir Age—Jan. 10, 1907. No. 81512.

The Cortlandt Street Tunnels and Terminal Building, New York. An illustrated article explaining the magnitude of the work and its present state. 1800 w. Sci Am—Jan. 26, 1907. No. 81926.

The Second Bergen Hill Tunnel of the Lackawanna R. R. An illustrated description of this new tunnel being constructed in connection with extensive terminal improvements at Hoboken, N. J. 1700 w. Eng Rec—Jan. 12, 1907. No. 81575.

Power Equipment of the Simplon Tunnel. Illustrates the hydraulic turbine built for the Brigue, Switzerland, power station, and describes features of the plant. 1400 w. Ry & Engng Rev—Jan. 26, 1907. No. 82007.

Warehouse.

A Warehouse Building of Composite Construction. Illustrated description of an addition to a building in Brooklyn,

mainly of reinforced concrete. 2000 w. Eng Rec—Jan. 5, 1907. No. 81494.

Wharf.

Ferro-Concrete Wharf at Hornchurch, Essex. Illustrates and describes a new wharf built entirely of Hennebique ferro-concrete. 600 w. Engng—Jan. 11, 1907. No. 81747 A.

MATERIALS OF CONSTRUCTION.

Australian Woods.

The Hard Woods of Western Australia. Information from a valuable report entitled "The Physical Characteristics of the Hard Woods of Western Australia," giving results of over 16,000 carefully-conducted tests on various samples of timber. 3500 w. Engng—Jan. 11, 1907. No. 81743 A.

Brick.

Sand Lime Brick Manufacture and Use. Description of old and new methods of manufacture, with illustrations of uses of this material. 1000 w. Munic Engng—Jan., 1907. No. 81386 C.

Cast Iron.

Shearing Strains in Freely Suspended Cast Iron Beams under Deflection Tests (Über die Beanspruchung freiaufliegender Träger durch Stoss mit Berücksichtigung der Schlagbiegeprobe für Gusseisen). A. Gessner. Description of testing apparatus and mathematical treatment of theory. Ills. 6700 w. Zeitschrift Des Osterreichischen Ingenieure und Architeken Vereines—Nov. 30, 1906. No. 81809 D.

Concrete.

Safety in Concrete Construction. Richard L. Humphrey. Presidential address before the Nat. Cement Users Assn. Discusses the test of the San Francisco earthquake upon this material, and also some of the abuses to which it is subjected. 3000 w. Eng Rec—Jan. 19, 1907. No. 81725.

Mortar.

The Composition and Strength of Mortar. W. J. Dibdin. Considers the relation of the composition to the resulting strength, giving facts of importance in tabular statements of experiments. Also general discussion. 11200 w. Jour Roy Inst of Brit Acchts—Dec. 22, 1906. No. 81701 B.

Ore Cement.

Cement for Sea-Water Construction. S. B. Newberry. Describes the properties of a new ore cement manufactured in Germany, which will not disintegrate in sea water. 800 w. Cement Age—Jan., 1907. No. 81798.

Timber.

The Steaming of Timber before Treating with Preservative. I. The Evolution of the Steaming Process. Octave Chanute. II. Air-Seasoning vs. Steaming. David Allerton. Two papers read before the Wood Preservers' Assn. 2000 w. Eng News—Jan. 31, 1907. No. 82029.

MEASUREMENT.

Longitude.

See Electrical Engineering, Communication.

Surveying.

A Property Survey and Its Cost. Arthur W. Tidd. Describes method used on some 1,000 acres of country surveyed for the Croton Falls Reservoir, being built for the city of New York, giving cost. 3300 w. Eng News—Jan. 10, 1907. No. 81557.

MUNICIPAL.

Bristol.

New Works at Bristol. Illustrates and describes the extensive improvements carried out by the Great Western Railway and by the Docks Committee of the Bristol Corporation, which have improved the communication between two parts of the city, enlarged the dock accommodation, and extended the railway facilities. 1800 w. Engr, Lond—Jan. 4, 1907. No. 81653 A.

Pavements.

Notes on Foreign Pavements. Notes from a report by B. T. Fendall, on a personal visit to England and the Continent for the purpose of examining the paving methods and results attained. 3500 w. Eng Rec—Jan. 19, 1907. No. 81724.

The Development of Wood Block Pavements in the United States. Frederic Arnold Kummer. A review of the development, explaining methods of laying, and some of the lines of progress. Ills. General discussion. 5000 w. Jour Assn of Engng Socs—Nov., 1906. No. 81387 C.

Septic Tanks.

Residential Septic Tanks. Burton T. Ashley. From a paper entitled "Sewage Disposal Without Sewers," read at Cleveland, O. Describes arrangements that proved most successful, and the later invention of a nitrification duct, explaining its use. 1400 w. Eng News—Jan. 31, 1907. No. 82020.

Sewage.

Experiments in Distribution of Sewage Over Sprinkling Filters at Waterbury, Conn. William Gavin Taylor. An account of tests made, and illustrated description of distributors with fixed sprinkler heads tested. 2500 w. Eng Rec—Jan. 5, 1907. No. 81490.

Modern Methods of Sewage Treatment (Über Moderne Abwasser-Reinigungsmethoden).—Dunbar. Address to the Section of Sanitary Technology, Hamburg. Review of most advanced systems of sewage treatment in Europe and the U. S. Ills. Serial. 2 parts. 11300 w.

Zeitschrift des Osterreichischen Ingenieure und Architekten Vereines—Nov. 16 and 23, 1906. No. 81833 each D.

Report on the Treatment of Part of the Sewage of Chicago and Its Relation to the Chicago Drainage Canal. Gives extracts from a report by Messrs. Rudolph Hering and George W. Fuller in regard to the sewage disposal for the Calumet area and the water supply of Chicago. 3500 w. Eng News—Jan. 31, 1907. No. 82025.

The Sterilization of Sewage-Filter Effluents. Earl B. Phelps and William T. Carpenter. Discusses desirability, the efficiency and cost, outlining a process of using gaseous chloride. 5500 w. Tech Qr—Dec., 1906. No. 81776 E.

Sewers.

Sewerage and Storm-Water Drainage in Johannesburg. Discussion of paper on this subject by D. C. Leitch, and G. S. Burt Andrews. 6500 w. Jour S African Assn of Engrs—Nov., 1906. No. 81518 F.

Waterworks.

See Water-Supply.

WATER SUPPLY.

Analysis.

The Analysis of Chalybeate Waters. C. Chester Ahlum. Explains the method employed by the writer. 1500 w. Jour Fr Inst—Jan., 1907. No. 81904 D.

The Volhard Method for the Determination of Chlorine in Potable Waters. Frank T. Shutt and H. W. Charlton. Trans. Roy. Soc. of Canada. Describes this method for the estimation of chlorine in waters, and compares its accuracy with the "chromate" method, showing its superiority when very small amounts of chlorine are to be determined. 1200 w. Min Rept—Jan. 17, 1907. No. 81713.

Aqueduct.

Report on the Proposed 226-Mile Aqueduct for the Water Supply of Los Angeles, Cal. Report upon the project for obtaining an additional supply of water from the Owens River and its tributaries. Ills. 6500 w. Eng News—Jan. 24, 1907. No. 81767.

The Owens River Aqueduct for the Los Angeles Water Supply. Principallv notes from the engineer's report on the plans for an aqueduct over 200 miles long, having a capacity of about 400 cubic ft. per second and a total fall of about 3,500 ft. built through a country ranging from rough to mountainous. Ills. 4800 w. Eng Rec—Jan. 26, 1907. No. 81952.

Contamination.

Prevention of the Bacterial Contamination of Streams and Oyster Beds. W. Pollard Digby and H. C. H. Shenton. Discusses the problem of sewage sterilization, describing the methods of obtaining purification from the bacteriological standpoint. Plate. 10500 w. Soc of Engrs—Dec. 3, 1906. No. 81799 N.

Dam.

See Civil Engineering, Construction.

High Pressure.

High-Pressure Fire Systems. F. L. Hand. Read before the Am. Water-Wks. Assn. Discusses the cost of Philadelphia's high-pressure pumping system and cost of maintenance, and gives a comparison of different systems. 5500 w. Ins Engng—Dec., 1906. No. 81406 C.

Irrigation.

Irrigation Works in Arizona. C. L. Gates. Treats of the reclaiming of the arid lands for agriculture, by irrigation, giving the cost of the Salt River storage tank and its accessories. 2300 w. Jour Assn of Engng Socs—Dec., 1906. No. 81910 C.

Marshfield, Wis.

The Improvements to the Water Supplies of Marshfield and Waupaca, Wis. W. G. Kirchoffer. Explains the existing conditions and the natural ground water supplies developed to increase and improve the water. 1800 w. Eng News—Jan. 31, 1907. No. 82021.

Meters.

Comments on Some French Tests of Water Meters. Clemens Herschel. Critical comments on the tests named, with remarks on tests made in America. 1000 w. Eng News—Jan. 3, 1907. No. 81377.

Pipe.

New Coupling for Cement Pipe. (Neue Verbindung von Betonrohren). R. Saliger. Illus. 1200 w. Beton und Eisen—Dec., 1906. No. 81862 F.

Comparison between Elliptical and Circular Section Earthenware Sewer Pipes. (Das Wirtschaftliche Wertberhältnis zwischen den ei und ellipsenförmigen und den kreisformigen Steinzeugröhren bei Schmutzwasserkanalisationen). Fr. Schmidt. Tables. 1800 w. Gesundheits Ingenieur—Dec. 1, 1906. No. 81851 D.

Reservoirs.

See Civil Engineering, Construction.

Review.

Water Supply. A review of the works completed and projected during 1906 both in England and other countries. 2800 w. Engr, Lond—Jan. 4, 1907. No. 81660 A.

Siphons.

Liberation of Air in Siphons. Charles Anthony, Jr. Gives an experiment made in connection with work in South Africa. 350 w. Pro Am Soc of Civ Engrs—Jan., 1907. No. 81913 E.

Sterilizing.

Stationary Water Sterilizing Apparatus. (Stationärer Trinkwasserbereiter). Herr Haefcke. Describes sterilizers for

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use in public buildings to furnish from 500 to 10000 liters per hour. Illus. 1900 w. Gesundheits Ingenieure—Oct. 27, 1906. No. 81853 D.

Storage.

Arrangement of Water Power Storage Reservoir. (Neuerungen an hydraulischen Akkumulierahlagen). Fritz Golwig. Description of a mode of regulating flow of water to a penstock by an auxiliary storage basin and electric control. Ills. 3300 w. Elektrotechnik und Maschinenbau—Dec. 2, 1906. No. 81825 D.

Waterworks.

The Water-Works System of Ilion, N. Y. Illustrates and describes works to supply wholesome water to a village of about 6,000 inhabitants, reviewing the history. 3000 w. Fire & Water—Jan. 19, 1907. No. 81715.

WATERWAYS AND HARBORS.

Borings.

Cost of Wash Drill Borings on the Deep Waterways Surveys, 1879 to 1900. An account of the borings made on the Deep Waterways between the Great Lakes and the Atlantic Tide Waters during 1897 and 1900. Also wash borings for the Rapid Transit commission, New York City. 2800 w. Eng News—Jan. 17, 1907. No. 81668.

Wash Drill Borings on the New York State Barge Canal. Emile Low. An Illustrated account of the methods employed in making borings on the work named, with the cost. 2700 w. Eng News—Jan. 17, 1907. No. 81667.

Canals.

Work on the 1,000 Ton Barge Canal and on Improved Highways in New York. Extracts from the report of Henry A. Van Alstyne, state engineer, covering the work of his department for 1905 and 1906. 3800 w. Eng News—Jan. 3, 1907. No. 81374.

Notes on the Evolution of Canal Electrification Methods. B. H. Thwaite. A discussion of canal electrification methods, the systems tried, and related matters of interest. 1700 w. Elec Rev, Lond—Jan. 18, 1907. Serial. 1st part. No. 81985 A.

Drainage Canal.

The Effect of the Chicago Drainage Canal on the Levels and Navigation of the Great Lakes. Quotes at some length an important report of the International Waterways Commission, with explanatory notes. The report recommends that the diversion of Lake Michigan water be limited to 10,000 cu. ft. per second. 5500 w. Eng News—Jan. 31, 1907. No. 82024.

Dredging.

Dredging the Hooghly. Illustrates a very powerful suction and discharging dredger, named Sandpiper, to be used for removing the difficulties of navigation on the river Hooghly. 800 w. Engr, Lond—Dec. 28, 1906. No. 81545 A.

Sand Dredging for Commercial Purposes. Richard J. Donovan. Illustrated description of work carried out on the Mississippi River and its tributaries, showing types of dredges used. 2500 w. Eng Rec—Jan. 5, 1907. No. 81495.

European.

European Practice on Waterways. D. A. Watt. Report submitted to the State Engineer of New York. Information in regard to recent and projected construction, depth of waterways, types of dams, design of locks, methods of towing, etc. 6500 w. Eng Rec—Jan. 19, 1907. No. 81720.

Harbors.

Harbors and Waterways in 1906. Remarks on the struggle between shipbuilders and harbor authorities, and brief comments on conditions of the Thames, Southampton, Dover, the Mersey, Manchester Ship Canal, the Humber, the the Tyne, Hartlepool, and East Coast ports, are given in the present number. 3500 w. Engr, Lond—Jan. 4, 1907. Serial. 1st part. No. 81654 A.

Panama.

Panama: The Railroad and the Canal. Fullerton L. Waldo. Information gathered during a visit from Dec. 28, 1906 to Jan. 2, 1907. Ills. 4000 w. R R Gaz—Jan. 18, 1907. No. 81687.

The Panama Canal. (Over den aanleg Van het Panamakanaal door de Vereeinigde staaten van Amerika). J. W. Welcker. History of the various canal schemes, and comparison of the plans for sea level or lock canal. Illus. 20000 w. De Ingenieur—Nov. 24, 1906. No. 81857 D.

The Panama Canal Work, and the Workers. Fullerton L. Waldo. An interesting personal study of actual conditions on the Isthmus which gives confidence in the wise management of affairs. Ills. 4000 w. Engineering Magazine—Feb., 1907. No. 81897 B.

MISCELLANY.

New Orleans.

A Study of the Effect of New Orleans Canal Waters on Crab Life. R. M. Redding. Gives results of a study of the cause for an abnormal mortality among the fish and crabs of Lake Ponchartrain, concluding that it was due to the absence of free oxygen in the water, brought about by the waters being heavily charged with organic matter. 1400 w. Jour Assn of Engng Socs—Dec., 1906. No. 81909 C.

1906 Review.

Civil Engineering. Brief reviews of conditions in Canada, Australia, New Zealand, Africa, Abyssinia, India, China, Thibet, the United States, Mexico, South

America, Russia, Turkey, Italy, France, Germany, London's Main Lines, bridges and tunnels. 6800 w. Engr, Lond—Jan. 4, 1907. No. 81659 A.

United States.

Engineering in the United States in 1906. Reviews some of the main directions of development, and some of the principal enterprises in which progress has been made during the year. 4000 w. Engr, Lond—Jan. 11, 1907. Serial. 1st part. No. 81751 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

On the Electric Radiation from Bent Antennae. J. A. Fleming. Abstract of a paper before the Physical Society. Describes experiments, with such antennae. 2500 w. Electn, Lond—Dec. 28, 1906. No. 81529 A.

The Lodge-Muirhead System of Wireless Telegraphy. C. C. A. Hardie. An explanation of this system, with diagrams. 1200 w. Elec Engr, Lond—Jan. 4, 1907. No. 81635 A.

The New Wireless Telegraph Station at Nauen, Germany. L. Ramakers. Illustrated detailed description of a great advance in construction and equipment of such stations with report of some of the remarkable results already obtained. 1000 w. Sci Am Sup—Jan. 26, 1907. No. 81933.

The Use of Wireless Telegraphy for Determining Longitude. A brief account of experiments made in Germany to test a possible application of wireless telegraphy to the determination of longitude. The conclusions were that this method is fully able to replace ordinary telegraphy for the practical determination of longitude. 800 w. Sci Am—Jan. 26, 1907. No. 81929.

Radio-Telephony.

Recent Progress in Wireless Telephony. Reginald A. Fessenden. An illustrated description of apparatus used, and an account of what has been accomplished in this field. 600 w. Sci Am—Jan. 19, 1907. No. 81689.

Telegraphy.

A Review of Telegraphy. William Maver, Jr. The progress during 1906 is reviewed in both wire telegraphy and radio-telegraphy. 2500 w. Elec Rev, N Y—Jan. 12, 1907. No. 81597.

The Future Telegraph System. William J. White. Discusses the lines of progress indicated, and reviews what has been accomplished. Outlines the systems of machine telegraphy and their defects, and the ideal to be aimed at in the future. 2000 w. Elec Rev, Lond—Jan. 4, 1907. No. 81639 A.

Telephony.

Independent Telephone Development. James B. Hoge. Reviews the history of the Independent movement. 6500 w. Jour Fr Inst—Jan., 1907. No. 81903 D.

Review of Telephony for 1906. Edward E. Clement. Reports the remarkable extension and discusses the present problems of the industry, the progress of invention in this field, and brief notice of the more important patents. 2500 w. Elec Rev, N Y—Jan. 12, 1907. No. 81596.

Telharmonic System.

Some Electrical Features of the Cahill Telharmonic System. A. S. McAllister. Illustrated description of the electrical features of the 200-ton equipment installed in New York. 2800 w. Elec Wld Jan. 5, 1907. No. 81500.

DISTRIBUTION.

Currents.

Wattless Currents. An explanation of the effects of induction and capacity in a circuit in which alternating current is flowing, in language familiar to those who are acquainted with the principles of continuous currents. 1200 w. Aust Min Stand—Dec. 19, 1906. Serial. 1st part. No. 81969 B.

Subway.

The Aberdeen Electric Cable Subway. Illustrated description of a subway a mile long, built in Scotland to carry feeder and pilot cables. 1000 w. Eng Rec—Jan. 26, 1907. No. 81953.

Underground Work for Telephone Cables in Bavaria. (Die vollständig unterirdische Zuführung den Teilnehmerleitungen in den Orts-Fernsprechanlagen Bayerns). Wilhelm Schreiber. Description of conduit, outlet boxes, circuits, etc. Ills. Serial. 2 parts. 6600 w. Elektrotechnische Zeitschrift—Dec. 13 and 20, 1906. No. 81836 each B.

Switches.

Modern Switchboard Devices. Illustrates and describes new designs of switches, explaining their operation. 1000 w. Elec Wld—Jan. 5, 1907. No. 81507.

Wires.

Some Critical Points in Electric Wiring. Donald Smeaton Munro. Abstract of a paper before the Students Soc. of Glasgow Inst, of Elec. Engrs. Describes various systems, pointing out their disadvantages and the precautions necessary, explaining how to make the work satisfactory. 3500 w. Elect'n, Lond—

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Jan. 11, 1907. No. 81740 A.

Wires Over Streets and Highways. An explanation of the English law on this subject. 1500 w. Elec Rev, Lond—Jan. 11, 1907. No. 81736 A.

ELECTRO-CHEMISTRY.

Cells.

The Standard Cell. F. A. Wolff and C. E. Waters. Gives important results of test at the U. S. Bureau of Standards, which show that the constancy of the e. m. f. of the cells depends largely on the methods employed in preparing the mercurous sulphate, and when proper materials are used the e. m. f. of different cells will vary but slightly. 1200 w. Elec Wld—Jan. 12, 1907. No. 81621.

Condensers.

Aluminium Electrolytic Condensers. O. M. Corbins and S. Maresca. Abstracted from *Il Nuovo Cimento*. Gives summary of results from a long series of experiments. 1000 w. Elect'n, Lond Dec. 20, 1906. No. 81528 A.

Electric Smelting.

The Application of Electricity to the Smelting of Iron Ores. Horace Allen. Briefly considers the chemical reactions involved in the reduction of iron and the present methods adopted, and gives figures showing the efficiency of electric furnaces for this work. 2200 w. Mech Engr—Jan. 12, 1907. No. 81729 A.

Use of the Electric Furnace for Iron and Steel. (Ueber die Fortschritte in der Elektrostahl-Darstellung). Prof. Eichoff. Exhaustive discussion of several forms of electric furnace for pig iron, steel, etc., with tables showing results obtained in controlling the composition of the product. Illus. Serial. 2 parts. 10500 w. Stahl und Eisen—Jan. 9, and 16, 1907. No. 81810 each D.

Electrochemistry and Electro-metallurgy in 1906. Charles F. Burgess. Remarks on the results of progress in this field, the electric furnace and its products, electroplating, etc. 2500 w. Elec Rev, N Y—Jan. 12, 1907. No. 81593.

Electrolysis.

The Application of the Electron Theory to Electrolysis. E. E. Fournier-d'Albe. Abstract of a paper read before the Faraday Soc. An investigation of electrolytic action on the basis of the electron theory. 2500 w. Elect'n, Lond—Jan. 18, 1907. No. 81986 A.

Storage Batteries.

Storage Batteries and Their Electrolytes. R. W. Vicarey. (Abstract.) Deals with the lead accumulator from the manufacturing point of view. Claims to have discovered a new irreducible sulphate of lead, and discusses the effect of certain impurities on current-density in formation. 2000 w. Elect'n, Lond—Dec. 28, 1906. No. 81527 A.

ELECTRO-PHYSICS.

Coils.

Electro-Magnetism. Roger Atkinson. An explanation of the electric current flow in a coil or helix. Ills. 900 w. Ry & Loc Engng—Jan., 1907. No. 81447 C.

Contribution to the Design of Electromagnet Coils for Powerful Currents (Beitrag zur Berechnung der Elektromagnetspulen für Starkstrom-Relais und dergl). Robert Edler. Mathematical paper; table and diagrams. Serial. 3 parts. 5600 w. Elektrotechnik und Maschinenbau—Dec. 16, 23 and 30, 1906. No. 81822 each D.

The Heating Coefficient of Magnet Coils. G. A. Lister. (Abstract.) Gives heating curves obtained in air with machine stationary, with machine running light, and with machine fully loaded. 800 w. Elect'n, Lond—Dec. 28, 1906. Serial. 1st part. No. 81526 A.

Dielectrics.

Spark Potentials in Liquid Dielectrics. Robert F. Earhart. Abstracted from the *Physical Review*. A report of experimental investigation. 600 w. Elect'n, Lond—Dec. 28, 1906. No. 81530 A.

Electromagnets.

Design of Electromagnets (Zur Berechnung der Elektromagnete). Fritz Emde. Mathematical Discussion of the calculation of the factors entering into the design of an electromagnet. Serial. 3 parts. 7000 w. Elektrotechnik und Maschinenbau—Nov. 25, Dec. 2 and 9, 1906. No. 81821 each D.

High-Frequency.

An Easily-Made High-Frequency Apparatus. A. Frederick Collins. Illustrates and describes this apparatus. 1200 w. Sci Am Sup—Jan. 5, 1907. No. 81382.

Induced E. M. F.

E. M. F. and Spark Discharge of a Secondary Current (Der Einfluss eines Sekundären Stromes auf Überspannung und Funkelbildung bei Stromunterbrechung). G. Benischke. A mathematical treatment of the subject of induced currents. 1500 w. Elektrotechnik und Maschinenbau—Nov. 18, 1906. No. 81820 D.

Induction Coils.

The Design of a 12-Inch Induction Coil. William O. Eddy. Aims to show the application of the principles of induction coil design. 2000 w. Elec Wld—Jan. 5, 1907. No. 81510.

Leakage.

Leakage Currents in the Moisture Condensed on Glass Surfaces. Prof. F. T. Trouton, and C. Searle. Abstract from the *Phil. Mag.* A report of experimental investigation of the behavior of these currents and the requirements necessary for the appearance of these sensitive conditions of the surface. 2000

w. Elect'n, Lond—Jan. 4, 1907. No. 81644 A.

Magnetic Leakage and Its Effect in Electrical Design. William Cramp. Read before the Manchester Sec. of the Inst. of Elec. Engrs. Considers both harmful and useful leakage, and methods of remedying the former in various machines. Gives an account of research work. Ills. 6000 w. Elec Engr, Lond—Jan. 11, 1907. Serial. 1st part. No. 81733 A.

Self-Induction.

Calculation of the Self-Induction of Coils (Berechnung der Selbstinduktion gerader Leiter und rechteckiger Spulen). J. K. Sumec. Mathematical discussion. 2100 w. Elektrotechnische Zeitschrift—Dec. 20, 1906. No. 81837 B.

Surges in Alternators.

Surges of E. M. F. in Machines having Slotted Armature and Field (Über Pulsationen der Zahninduktion in Maschinen Mit Nuten im feststehenden und rotierenden Teil). O. S. Brogstad. Mathematical treatment of the subject of harmonics in A. C. Machines. Ills. 1200 w. Elektrotechnik und Maschinenbau—Dec. 30, 1906. No. 81832 D.

GENERATING STATIONS.

Armatures.

Armature Laminations for Dynamos. H. M. Hobart. Discusses the material most suitable for armature laminations, and describes Ewing's hysteresis tester and its use, in the present article. 3500 w. Mech Engr—Jan. 5, 1907. Serial. 1st part. No. 81632 A.

Alternating-Current Armature Windings and Their Classification. H. M. Hobart and A. G. Ellis. Considers the derivation of single-phase windings, defining fundamental terms, discussing the types of coil, development of polyphase windings, etc. Gives a general scheme for nomenclature and classification of alternating-current windings and their application, showing the properties of a winding completely defined by its title. Ills. 2000 w. Elect'n, Lond—Jan. 4, 1907. Serial. 1st part. No. 81640 A.

Armature Notes. Arthur B. Weeks. Suggestions for overcoming difficulties. 1300 w. Elec Wld—Jan. 5, 1907. No. 81508.

Estimation of Armature Diameter. L. A. Freudenberger. Explains the usual method of determining the armature diameter, and armature power. 1000 w. Elec Wld—Jan. 19, 1907. No. 81718.

Central Stations.

General Tendencies in Central Station Practice. Frank Koester. Reviews features in the design and construction of power plants and their equipment, and the economical operation. 2000 w. Elec Rev, N Y—Jan. 12, 1907. No. 81595.

Technical Graduates and Central Stations. Prof. George D. Shepardson. Presents some of the reasons why so few technical graduates are connected with central stations. 1400 w. Elec Wld—Jan. 5, 1907. No. 81502.

Costs.

Graphical Method of Estimating Cost of Electrical Energy (Graphische Ermittlung der Gestehungskosten elektrischer Energie). Karl Kramar. Exposition of a graphical method for estimating costs per k. w. hour. Ills. Tables and diagrams. 1800 w. Elektrotechnik und Maschinenbau—Dec. 23, 1906. No. 81814 D.

Dynamos.

Mechanical Calculations and Data for Dynamo Design. Eric A. Lof. Gives methods and data for properly dimensioning some parts of the dynamo. Ills. 1200 w. Mach, N Y—Jan., 1907. No. 81411 C.

Fuel.

Fuel Economy. H. B. Maxwell. Read before the Glasgow Sec. of the Inst. of Elec Engrs. Deals principally with the steam plant of an electric generating station, but the general principles are applicable to all steam plants. Considers the requirements to obtain the utmost economy are one economizer, air-heating, no chimney, an induced-draft fan and live-steam heating of the feed. 5000 w. Elec Engr, Lond—Jan. 1, 1907. No. 81735 A.

Hydro-Electric.

Hydro-Electric Plant at Kakabeka Falls, Canada. W. G. Hewson. Illustrated description of a recent Canadian installation designed to supply the town of Fort William with electricity for all purposes. 1800 w. Elec Wld—Jan. 26, 1907. No. 81940.

The Pueblo and Suburban Traction and Lighting Company's Hydro-Electric Plant. Illustrates and describes this plant and hydraulic development of Colorado. 3800 w. Elec Rev, N Y—Jan. 26, 1907. No. 81954.

The Roaring Fork Electric Light and Power Company. Illustrated account of the development of this Colorado installation, describing the interesting features. 2500 w. Elec Rev, N Y—Jan. 5, 1907. No. 81441.

Johnstown, Pa.

Power Stations of the Citizens Light, Heat and Power Company of Johnstown, Pa. Illustrates and describes two stations, one a direct-current station supplying current and also exhaust steam for heating; the other a turbine-driven station supplying alternating-current. 2500 w. Elec Wld—Jan. 5, 1907. No. 81498.

Management.

Some Phases of Smaller Central Station Management. Abstract of a

paper by H. H. Scott, read at meeting of the N.-W. Elec. Assn. Deals with the physical and commercial departments, and points leading to the development of the highest efficiency and economy. Also short discussion. 2500 w. Elec Wld—Jan. 26, 1906. No. 81945.

Marylebone.

The Marylebone Municipal Electrical Undertaking. Briefly reviews the history of this undertaking and gives an illustrated detailed description of the station, plant, etc. 3500 w. Elec Rev, Lond—Jan. 18, 1907. No. 81984 A.

Paris.

The St. Denis Power Station, Paris. Illustrated description of a fine modern station, its steam and electrical equipment, including 6,000-kilowatt turbo-alternators. 1500 w. Elec Rev, Lond—Jan. 11, 1907. No. 81737 A.

Rates.

Systems of Charging for Electricity Supply. W. A. Toppin. Considers the different systems of charging in general use, comparing their advantages and disadvantages, and explains a system worked out by the writer. 3000 w. Elec Engr, Lond—Jan. 11, 1907. No. 81731 A.

Wiring.

The Wiring of Small Central Stations. S. L. Sinclair. Remarks on the work and responsibility of the erecting engineer, considering briefly switchboards, generator cables, feeders, lights, motors, starters, protective apparatus, etc. 2000 w. Elec Jour—Jan., 1907. No. 81788.

LIGHTING.

Circuit Extensions.

Extending Lighting Circuits in Completed Fireproof Building. T. W. Poppe. Describes the work of changing outlets. Ills. 1200 w. Elec Wld—Jan. 5, 1907. No. 81509.

Colloids.

Some Notes on Colloids. Appendix to the article on the "New Incandescent Electric Lamps." (No. 81030.) Notes furnished by Prof. Lottermoser for the better comprehension of recent developments, particularly the discovery of Kuzel. 2000 w. Engr, Lond—Dec. 28, 1906. No. 81541 A.

Combined Plant.

Report on a Combined Refuse Destructor and Electric Lighting Plant for East Orange, N. J. Abstract of a report made by Henry Floy. Gives a statement showing the effect of refuse destructor heat utilization upon the fuel bill of an electric lighting station, and the effects of a combination of garbage and rubbish, compared with garbage, rubbish, and ashes under the conditions given. 2500 w. Eng News—Jan. 24, 1907. No. 81769.

Illumination.

Some Points on Illuminating Engineering for the Small Central Station. J. R. Cravath. Read before the N.-W. Elec. Assn. Gives suggestions of value as to things to be aimed at and avoided in securing good illuminating results. 2800 w. Elec Wld—Jan. 26, 1906. No. 81944.

Light. W. R. Whitney. A brief review of present schemes for the production of electric light, considering the possible limitations, and present efficiency. 2500 w. Sib Jour of Engng—Jan., 1907. No. 81914 C.

The Comparative Economy of Various Methods of Illumination. Information relating to the efficiency and cost of various illuminants. 2000 w. Sci Am Sup—Jan. 12, 1907. No. 81572.

The Rudiments of Illumination. Dr. Louis Bell. A discussion of the choice and placing of illuminants, and matters affecting the distribution. 2000 w. Elec Wld—Jan. 5, 1907. No. 81503.

Calculation of Luminous Intensity at Various Angles (Beleuchtungsberechnungen). L. Bloch. Examination of results of photometric tests of arc and incandescent lamps at different angles. Tables and diagrams. Serial. 2 parts. 6800 w. Elektrotechnische Zeitschrift—Dec. 6 and Dec 13, 1906. No. 81835 each B.

Lamps.

Developments in Electric Lamps During 1906. Dr. Clayton H. Sharp. A review of the progress of the year, especially the improved filaments, and the efficiency of the tungsten lamp. 1500 w. Elec Rev, N Y—Jan. 12, 1907. No. 81590.

Helion Filament Incandescent Lamp. Prof. H. C. Parker and Walter G. Clark. Read before the Am. Phys. Soc. A description of lamps having filaments which are not metallic, which can be operated at 1 watt per candle, at a temperature much below the temperature of metallic filaments operated at this consumption. Ills. 1500 w. Elec Wld—Jan. 5, 1907. No. 81496.

New Incandescent Lamps. J. Swinburne. Read before the Inst. of Elec. Engrs. Reviews the history of the development of these lamps, discussing the metallic filaments now being considered. 5800 w. Elec Engr, Lond—Jan. 11, 1907. Serial. 1st part. No. 81734 A.

New Types of Incandescent Lamps. Clayton H. Sharp. Considers new processes of manufacture and new filaments, especially the peculiarities or the properties of the tantalum and the tungsten lamps. 6800 w. Pro Am Inst of Elec Engrs—Dec., 1906. No. 81907 D.

Tungsten Lamp Patent. Specifications and claims of this first patent. 1200 w. Elec Wld—Jan. 5, 1907. No. 81497.

Streets.

Side-Street Lighting. A. C. Hanson. Remarks on the various methods tried

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for lighting side-streets. Considers the tantalum lamp best suited for this purpose, explaining the writer's methods. 1400 w. Elec Rev, Lond—Jan. 18, 1907. No. 81983 A.

Theory.

Electric Lighting and Heating. This introductory article considers the theory, progress in applications, metallic filament lamps, conversion of electric power into light, industrial changes effected by cheap power, etc. 3000 w. Builder—Jan. 5, 1907. Serial. 1st part. No. 81624 A.

MEASUREMENT.

Circuits.

Measurements of Inductance and Impedence. J. Elton Young. Discusses the measurement of inductance and impedance of telegraph and telephone circuits, including overhead wires, loops, single-wire, concentric, submarine and other cables. 3000 w. Elect'n, Lond—Dec. 28, 1906. Serial. 1st part. No. 81525 A.

Cymometer.

The Fleming Direct-Reading Cymometer and its Applications. An illustrated description of the cymometer as designed by Dr. J. A. Fleming, and the method of using the instrument for the determination of wave length, frequency, capacity, inductance, etc. 2500 w. Elect'n, Lond—Jan. 11, 1907. Serial. 1st part. No. 81741 A.

Interrupter.

A Rotary Interrupter for Capacity Measurements. F. Kurlbaum and W. Jaeger. Abstracted from *Zeits. für Instrumentenkunde.* Illustrates and describes a rotary interrupter for high frequencies, constructed in accordance with the well-known principles of the "secohmeter" of 1887. 400 w. Elect'n, Lond—Jan. 4, 1907. No. 81643 A.

Polyphase.

Polyphase Power Measurement. C. A. Adams. A simple proof of the accuracy of the two-watt meter method of measuring three-phase power. 1000 w. Elec Wld—Jan. 19, 1907. No. 81717.

Resistance.

Notes on a Graphical Proof of the Rule for Comparing Resistances by the Kelvin Double Bridge. A. E. Moore. Explains a graphical proof devised by the writer which gives a clear conception of the principles involved. 1500 w. Elec Engr, Lond—Dec. 28, 1906. No. 81522 A.

Temperature.

Heating of Wires with Temporary Current Rush. Explains a method of calculating the rise of temperature of wires caused by an excessive current flowing for a short time. 600 w. Prac Engr—Jan. 4, 1907. No. 81631 A.

Time.

Electric Measurement of Brief Intervals of Time. A detailed explanation of the method used. 1200 w. Elec Rev, Lond—Jan. 4, 1907. No. 81637 A.

MOTORS.

Induction Motors.

Notes on Induction Motor Characteristics and Their Bearing on its Applications. J. W. Rogers. Briefly considers the characteristics which have a direct bearing on its application to any particular class of work, and the manner in which they are affected by different conditions of the supply circuit. Also the selection of the most suitable type for any particular service. 2000 w. Elec Engr, Lond—Jan. 18, 1907. No. 81980 A.

Practical Testing of Induction Motors. R. E. Hellmund. Discusses some of the phenomena causing inexactnesses in results derived from diagrams. 2000 w. Elec Rev, N Y—Jan. 19, 1907. No 81700.

The Leakage Reactance of Induction Motors. A. S. McAllister. Gives formulas for deriving the dispersion factor from the dimensions of any given induction motor. Also editorial. 2800 w. Elec Wld—Jan. 26, 1907. No. 81941.

Synchronous Motors.

Graphic Solutions of Some Synchronous Motor Problems. William Tatlow. Gives graphic solutions of problems in connection with syuchronous motors, explaining the meaning of the symbols used. 1000 w. Elec Engr, Lond—Jan. 4, 1907. No. 81634 A.

Troubles.

Motor and Dynamo Troubles. W. T. Fernandez. Examines some causes of troubles in these machines and the remedies. 1200 w. Power—Jan., 1907. No. 81461 C.

TRANSMISSION.

See also Distribution.

Concrete Poles.

The Siegwart Concrete Pole. (Der Siegwart-Zementmast). S. Herzog. Reinforced concrete mast for electric wires, made by a new process devised by Hans Siegwart, of Lucerne. Illus. 1300 w. Dec. 23, 1906. No. 81829 D.

Development.

Development in Electrical Transmission. F. A. C. Perrine. A review of the extension of lines and plants, and some of the difficulties. 1600 w. Elec Rev, N Y—Jan. 12, 1907. No. 81592.

High-Tension Cables.

Experiments with High Potentials. An illustrated account of some high-tension experiments at the Milan Congress conducted by E. Jona on cables and aerial lines with exceedingly high potentials. Also editorial. 2000 w. Elec Wld—Jan. 26, 1907. No. 81942.

Long Distance.

Long-Distance Power Transmission with Direct Currents. C. T. Wilkinson. Gives a detailed account of the latest developments of the work of M. Thury. Ills. 3000 w. Cassier's Mag—Jan., 1907. No. 81782 B.

Long Spans.

Long Spans for Power Transmission Lines. T. L. Kolkin. An investigation to determine which length of span will make the cheapest pole line for the various sizes of wires. 700 w. Elec Rev, Lond—Dec. 28, 1906. No. 81523 A.

Subway.

See Distribution.

Wire Spans.

Simple Formulæ for the Relations Between Deflection, Tension and Temperature in Wire Spans. Harold Pender. Approximate formulæ for determining changes due to temperature. 500 w. Elec Wld—Jan. 12, 1907. No. 81620.

MISCELLANY.

London.

London's Electrical Supply. A short résumé of the history. 1800 w. Elec Rev, Lond—Jan. 4, 1907. No. 81638 A.

Protection.

Recent Investigation of Lightning Protective Apparatus. R. P. Jackson. Outlines the characteristics of lightning as manifested on electric circuits and recent investigation as to what characteristics protective devices should possess and to what degree they have been found in practice to possess them. 4500 w. Pro Am Inst of Elec Engrs—Dec., 1906. No. 81908 D.

Review.

Electrical Engineering Progress in the United States in 1906. Henry H. Norris. A brief review of the year's work showing the magnitude of the undertakings in progress. 2800 w. Sib Jour of Engng—Jan., 1907. No. 81916 C.

Electrical Engineering in 1906. A review of electrical power supply schemes, electric railways, haulage on canals, omnibuses, lighting, and various uses of electricity. 6000 w. Engr, Lond—Jan 4, 1907. No. 81656 A.

INDUSTRIAL ECONOMY

Accounting.

A System of Factory Cost Accounting. D. C. Eggleston. Outlines systems used by manufacturing companies. 1800 w. Jour of Accountancy—Dec., 1906. No. 81900 C.

Cement.

The Cement Industry of the World. Robert W. Lesley. A brief résumé of the situation at home and abroad, showing the United States far in the lead. 10000 w. Cement Age—Jan., 1907. No. 81796.

Chinese Trade.

Mechanical Agencies in the Development of Chinese Export Trade. Barrett Smith. Illustrates and describes the application of hydraulic press packing in China for shipment of raw materials to America and European markets, which makes possible the large export trade at present freight rates. 3800 w. Engineering Magazine—Feb., 1907. No. 81898 B.

Cost.

Manufacturing Cost. R. H. Probert. Abstract of a paper read before the Ohio Soc. of Mech., Elec., and Steam Engrs. Briefly considers the chief elements entering into the cost of manufacture. 2000 w. Ir Trd Rev—Jan. 3, 1907. No. 81404.

Cost Systems.

The Proper Treatment of Machine Costs.—A Criticism and a Theory. Andrew A. Murdoch. Comments on Mr. Whitmore's articles on Machine Shop Costs, especially emphasizing the importance of reorganizing machine labor as a basic element of cost. 3300 w. Jour of Accountancy—Dec., 1906. No. 81901 C.

Labor: Time Systems and Pay Roll. F. E. Webner. Fifth of a series of articles on cost keeping. Deals principally with time recording. 1700 w. Ir Trd Rev—Jan. 3, 1907. No. 81403.

Education.

A Comparison of University and Industrial Methods and Discipline. Frederick W. Taylor. An address delivered at the dedication of the new Engineering Building of the University of Pennsylvania. Considers the preparation of young men for success in commercial engineering and industrial enterprises. 3500 w. Pro Am Soc of Mech Engrs—Jan., 1907. No. 81388.

Engineering Education and Engineering Ethics. Charles Day. Read before the Phila. Branch of the Am. Inst. of Elec. Engrs. Discusses the future in engineering practice, and the tendency and necessity for co-operation. 2500 w. Pro Am Inst of Elec Engrs—Dec., 1906. No. 81906 D.

Engineering Education. B. A. Behrend. A discussion of present methods of instruction, calling attention to defects, and considering the influences that seriously affect the results. 5500 w. Elec Wld—Jan. 5, 1907. No. 81501.

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Technical Foundry Education. H. E. Field. Read before the New England Found. Assn. Discusses some defects of technical schools and colleges, and the preparation and discipline needed, especially considering foundry education. 4000 w. Ir Trd Rev—Jan. 3, 1907. No. 81405.

Fire Losses.

Fire losses in the United States. Showing the enormous loss by fire, and discussing some of the causes. 3800 w. Engr, Lond—Dec. 28, 1906. No. 81547 A.

Iron Trade.

Forty-two Years in the Iron Trade. Dr. William Kent. A review showing the wonderful increase in production. 6500 w. Ir Trd Rev—Jan. 10, 1907. No. 81551.

The Development of the American Iron Industry. Edwin C. Eckel. A study of output and reserves, recent technical advances in ore treatment, and the influence of the Steel Corporation. 3500 w. Engineering Magazine—Feb., 1907. No. 81899 B.

The Chicago Iron Trade in 1906. A. O. Backert. A review of the production, consumption, extensions, prices, and related matters of interest. 3800 w. Ir Age—Jan. 3, 1907. No. 81368.

The Cincinnati Pig Iron Trade in 1906. James A. Green. A report, giving notes recorded monthly which reflect the conditions at the time they were written. 4000 w. Ir Age—Jan. 3, 1907. No. 81365.

The International Outlook in the Iron Trade. J. Stephen Jeans. A brief discussion of the resources, demands, consumption, etc., in Europe and America. 4200 w. Mfr's Rec—Jan. 3, 1907. No. 81370.

The Lake Iron Ore Trade in 1906. Dwight E. Woodbridge. Remarks on the importance of the "Hill ore deal," developments in stripping, search for new mines, shipping, etc. 3000 w. Ir Age—Jan. 3, 1907. No. 81370.

The Italian Iron Industry. (Italiens Eisenindustrie). H. Wedding. General account of the location and kind and amount of output of the principal iron works of Italy. Illus. 3400 w. Stahl und Eisen—Jan. 2, 1907. No. 81807 D.

Pig Iron and Ore. Gives statistics of production, a summary of commercial conditions, and a review of the industry. 13500 w. Eng & Min Jour—Jan. 5, 1907. No. 81480.

The Philadelphia Iron Trade in 1906. Thomas Hobson. A review of the consumption, production, prices, materials, etc. 3800 w. Ir Age—Jan. 3, 1907. No. 81369.

The Pittsburgh Iron Trade in 1906. Robert A. Walker. A review of the general features, prices, new construction, labor, foreign trade, and products. 5500 w. Ir Age—Jan. 3, 1907. No. 81367.

Safety Devices.

An Exposition of Safety Devices and Industrial Hygiene. Gives startling facts in regard to the great sacrifice of human life in industrial vocations, and illustrates some of the safety devices exhibited at an exposition at the American Museum of Natural History, New York City. 2000 w. Sci Am—Jan. 26, 1907. No. 81927.

Steel Works.

The Productive Efficiency of Steel Works. James Waite. Abstract of a paper read before the Cleveland, Eng. Inst. of Engrs. Suggestions for tracing the inefficiencies, and describing British practice. 1500 w. Ir Age—Jan. 31, 1907. No. 82016.

MARINE AND NAVAL ENGINEERING

Battleships.

Speed Trials of the Battleship "Vermont." Illustrated description of this battleship, with report of the standardization trials. 700 w. Sci Am—Jan. 5, 1907. No. 81380.

The Tactical Qualities of the "Dreadnought" Type of Battleship. W. S. Sims. Gives the main points of an interesting report favoring this type. Also editorial. 10300 w. Engng—Jan. 11, 1907. No. 81749 A.

Coaling Barge.

The Clarke Automatic Coaling-Barge. Illustrates a type of these coaling barges used for coaling "over-all," explaining its working. 800 w. Engng—Jan. 18, 1907. No. 81999 A.

Destroyer.

The Italian Torpedo-Boat Destroyer "Espero." Illustrates and describes some recent additions to the torpedo flotilla of the Italian navy. 1000 w. Engng—Jan. 11, 1907. No. 81745 A.

Docks.

Middlesbrough Docks. W. G. Kyle. An illustrated account of what has been achieved in the reconstruction of these docks, which are practically completed. 2500 w. Ir & Coal Trds Rev—Jan. 18, 1907. No. 82003 A.

Dredge.

Steam Seagoing Dredge "Thor" (Der Seedampfbagger "Thor" der Weichselstrombauverwaltung). Herr Meiners. Large dredge for harbor improvement

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service, with details of steam and electrical machinery installed. Ills. 2000 w. Zeitschrift Des Vereines Deutscher Ingeniure—Dec. 8, 1906. No. 81824 D.

Dry Docks.

Modern Floating Dry Docks. A. C. Cunningham. A lecture at the Mass. Inst. of Tech. An illustrated article explaining in a general way the important principles of floating dry docks. 7000 w. Tech Qr—Dec., 1906. No. 81775 E.

The Voyage of the Dewey. F. M. Bennett. An account of the fitting out and of the seafaring mishaps, accidents and obstacles met with, and expedients resorted to by the naval expedition that transferred the floating dry dock Dewey from Chesapeake Bay to the Philippine Islands. Ills. 20500 w. Pro of the U S Nav Inst—Dec., 1906. No. 81673 F.

Electricity.

Electrical Installations of the United States Navy. Burns T. Walling and Julius Martin. A manual of the latest approved material, including its use, operation, inspection, care, and management, and method of installation on board ships. Ills. 51800 w. Pro U S Nav Inst—Dec., 1906. Serial. 1st part. No. 81674 F.

Engines.

See Mechanical Engineering, Combustion Motors and Steam.

England.

Progress of Warships and Machinery Under Construction in England. A review of events of importance in this field. 2000 w. Engr, Lond—Jan. 11, 1907. No. 81753 A.

Gyrostat.

Practical Tests of the Gyrostat for Ships. Otto Schlick. An account of a test made of this device to diminish the rolling of ships, which gives reasons for believing it can be successfully applied. Ills. 2300 w. Sci Am Sup—Jan. 26, 1907. No. 81932.

Ice Breaker.

Combined Ice-Breaking, Salvage, and Survey Steamer for the Canadian Government. Illustrated description of the "Lady Grey," a steamer for service on the St. Lawrence River, for the purpose of maintaining an open channel to the sea during the winter. 6000 w. Sci Am Sup—Jan. 26, 1907. No. 81930.

Life-Saving Service.

United States Revenue Cutter No. 16. Drawings and particulars of a new single screw steel cutter for life-saving service on the North Pacific Coast of the United States. 4000 w. Int Marine Engng—Feb., 1907. No. 81761 C.

Model Basins.

Ship Model Stations. Cecil H. Peabody. Gives a general statement of the methods of testing models, and describes three governmental and three private stations visited. 6500 w. Tech Qr—Dec., 1906. No. 81774 E.

Motor Boats.

"Britannia I." Brief illustrated description of Sir Thomas Lipton's motor boat. 400 w. Auto Jour—Jan. 19, 1907. No. 81974 A.

Salving.

The Raising of the Bavarian. A description, with illustrations, of the first use of compressed air in raising stranded vessels, in the case of the 12,000 ton Allan Liner which ran on the Wye Rock, near Quebec, on the night of Nov. 3, 1905. 1800 w. Compressed Air—Jan., 1907. No. 81789.

Shipbuilding.

Extensions at Elswick and Openshaw. Describes important schemes in progress for the extension and improvement of the works and shipyards. 1500 w. Engr, Lond—Jan. 4, 1907. No. 81662 A.

Shipbuilding and Marine Engineering During 1906. A review of the work accomplished showing the great magnitude and discussing the interesting features and progress. 2000 w. Engr, Lond—Jan. 18, 1907. Serial. 1st part. No. 81993 A.

Steamer.

New Steamer J. H. Sheadle. Illustrated detailed description of a modern lake bulk freighter. 3800 w. Marine Rev—Jan. 3, 1907. No. 81438.

New Steamer City of Cleveland. Illustrated description of a new lake steamer of exceptional beauty, recently launched, for service between Detroit and Cleveland. 3000 w. Marine Rev—Jan. 10, 1907. No. 81599.

Stern-Wheel Steamer "Endeavor" for the Baptist Missionary Society. Illustrations, drawings, and description of a steamer for service on the Congo. 700 w. Engng—Jan. 18, 1907. No. 82000 A.

Steamships.

Steamship Anticipation for 1907. Principally a discussion of the engineering features of the Lusitania and Mauretania. 1700 w. Engr, Lond—Jan. 18, 1907. No. 81992 A.

Submarines.

The Limitations of the Diving Submarine. Robert G. Skerrett. Reviews the experience of diving submarines in America, France, Great Britain and Russia, discussing the lessons and conclusions. Ills. 12800 w. Jour U S Art—Nov., 1906. No. 81772 D.

The Position of the Submarine. Editorial discussion of this question in connection with the details of the past year's work in the British navy. 2500 w. Engng—Dec. 28, 1906. No. 81537 A.

The Stability of Submarines. W. H. Stuart Garnett. Considers some of the dangers inseparable from the present type

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of submarine boat, and means of lessening them, with a few suggestions for possible improvements. 3500 w. Cassier's Mag—Jan., 1907. No. 81785 B.

Turbines.

The Turbine Steamer Governor Cobb. Description, with many illustrations, of the first American-built turbine-propelled steamship. 1800 w. Int Marine Engng—Feb., 1907. No. 81759 C.

Warships.

Warship Construction in 1906. A detailed account of last year's work in the British navy. 3500 w. Engng—Dec. 28, 1906. No. 81538 A.

Yachts.

The Khedive's Yacht "Mahroussa." Illustrated detailed description of this reconstructed yacht, including the fitting of new boilers and turbine machinery, the removal of the side paddle-wheels, and the reconstruction of the stern to suit triple-screw propulsion. 1400 w. Engng—Jan. 4, 1907. No. 81652 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Accessibility.

Accessibility and Cleanliness. F. Leigh Martineau. Read before the Inst. of Auto. Engrs. A study of this subject, considering both horizontal and vertical engines. 2500 w. Autocar—Jan. 19, 1907. Serial. 1st part. No. 81976 A.

Adams-Eight.

The Adams-Eight 35-40 H. P. Car. An illustrated review of the special features of this British car. 2000 w. Autocar—Jan. 19, 1907. No. 81975 A.

Air-Cooled.

German Air Cooled Motors (Luftkühlvorrichtungen an deutschen Motorwagen). Wolfgang Vogel. Several types of air cooled automobile engines described and illustrated. 1700 w. Zeitschrift des Mitteleuropäischen Motorwagen-Vereins—No. 19. Oct., 1906. No. 81863 D.

American.

The American Cars of 1907 in General. Brief description of new models shown at the seventh automobile show. Ills. 4000 w. Automobile—Jan. 17, 1907. No. 81676.

Appraising.

Appraising Imported Cars for Customs Duty. Harry W. Perry. Information as to the method of making an examination, and the work of the appraiser's office. Ills. 2000 w. Automobile—Jan. 10, 1907. No. 81618.

Aries.

The Aries Petrol Cars. Illustrates details of a 30-h. p. chassis, which give a very correct impression of the standard Aries design, with descriptive notes. 1600 w. Auto Jour—Jan. 12, 1907. No. 81727 A.

Cadillac.

The Cadillac 20-Horse-Power Four-Cylinder Engine and Governor. Walter Galland. Illustrated description of the motor of this new light-touring car. 600 w. Sci Am—Jan. 12, 1907. No. 81568.

The 30-H. P. Cadillac Car. Illustrated description of this new car, and the three-speed epicyclic gear introduced. 2000 w. Auto Jour—Jan. 19, 1907. Serial. 1st part. No. 81970 A.

Commercial Cars.

The Commercial Vehicles of the Show. Howard Greene. Describes some of the types exhibited. 1800 w. Automobile—Jan. 17, 1907. No. 81678.

Converted Engine.

A Converted Otto Cycle Engine. Illustrates and describes an invention of C. R. Crosher, which appears to have removed some of the disadvantages of the two-stroke motor. 800 w. Autocar—Dec. 29, 1906. No. 81520 A.

Cylinder Lubrication.

Cylinder Lubrication of Benzine Motors (Zylinderschmierung von Benzinmotoren). Herr Pflug. Properties of oils from different manufacturers compared as to viscosity, action under influence of heat, etc. 1200 w. Zeitschr d Mit Motorwagen Ver—No. 20. Oct., 1906. No. 81865 D.

De Dion.

The New 8-H. P. De Dion Engine. Illustrated description of a beautifully designed little single-cylinder petrol engine. 1400 w. Auto Jour—Jan. 19, 1907. No. 81972 A.

Design.

Questions of Motor Car Design. Remarks on faults in designing which also increase the cost needlessly. Ills. 2800 w. Engng—Jan. 18, 1907. No. 81996 A.

Some Early American Automobiles. Illustrations, with brief descriptions of steam machines, an electric automobile, and early gasoline cars. 3300 w. Sci Am—Jan. 12, 1907. No. 81567.

Eight-Cylinder.

Hewitt Uncovers an Eight-Cylinder Creation. Describes the Hewitt 50-60 h. p. touring car, especially the details of its 8-cylinder motor. Ills. 1000 w. Automobile—Jan. 17, 1907. No. 81679.

Emergency Wagon.

An Automobile Emergency Wagon for Fire Departments. Illustrated description of an interesting vehicle for carrying

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men and apparatus for controlling incipient fires. In service at Springfield, Mass. 800 w. Sci Am Sup—Jan. 26, 1907. No. 81934.

Engine.

Engine of the Car de Luxe. Illustrates and describes the novel features of an automobile engine of the highest grade. 600 w. Sci Am—Jan. 12, 1907. No. 81569.

European.

The Foreigners of the Garden Show. Remarks and brief descriptions of models shown, especially the 1907 designs. 1800 w. Automobile—Jan. 17, 1907. No. 81677.

Exposition.

Automobiles at the Leipsic Show, October, 1906 (Die Leipziger Krystallpalast Ausstellung 5-14 Oktober, 1906). Description of automobile exhibits. 2000 w. Zeitschr d Mit Motorwagen Ver No. 19. Oct., 1906. No. 81864 D.

Garage.

The Metropolitan Garage. A. Jordahl. Illustrated description of a reinforced concrete building being erected in New York City. 1000 w. Eng Rec—Jan. 12, 1907. No. 81580.

Horse-Power.

Variation in Horse-Power Developed by Automobile Gas Engines. A. E. Potter. Explains the meaning of horsepower and power rating. 2500 w. Sci Am Sup—Jan 26, 1907. No. 81935.

Ignition.

Care of the Ignition Storage Battery. H. Gernsback. Information in regard to the inspection of a new battery, how to test the cells, and matters relating to its care. 1000 w. Automobile—Jan. 3, 1907. No. 81419.

Lanchester.

The Six-Cylinder Lanchester Car. Illustrated detailed description of this 28-h. p. car, which differs in design from the majority of the cars in use. 1500 w. Autocar—Jan. 5, 1907. Serial. 1st part. No. 81627 A.

Mercedes.

The 6-Cylinder Mercedes Car. Illustrated description of an entirely new model. 1200 w. Auto Jour—Jan. 5, 1907. No. 81628 A.

Napier.

The 40-H. P. 6-Cylinder Napier Car. Views and description of features of this 40-h. p. live-axle chassis. 1200 w. Auto Jour—Jan. 12, 1907. No. 81726 A.

Pittler Transmission.

The Pittler Hydraulic Transmission for Motor-Cars. Illustrated description of a novel system. Only the general arrangement as applied to motor cars is given. 1600 w. Motor Car Jour—Jan. 5, 1907. No. 81625 A.

Pope-Hartford.

The 25-H. P. Pope-Hartford Petrol Car. Illustrates and describes the interesting features of this American car. 1200 w. Auto Jour—Jan. 19, 1907. No. 81971 A.

Royal Tourist.

Royal Tourist for 1907. Illustrates and describes the improvements found in the 1907 model. 2000 w. Automobile—Jan. 24, 1907. No. 81918.

Small.

Small Automobiles (Die kleinen Motorwagen). Description, with particulars and dimensions of 31 cars, of less than 1,500 pounds weight. Ills. 8300 w. Zeitschr d Mit Motorwagen Ver—No. 20. Oct., 1906. No. 81866 D.

Starter.

The Letombe Self-Starter. Illustrated description of the device which obtained the first award at the recent trial in Paris in connection with the Deutsch Prize. 700 w. Auto Jour—Jan. 19, 1907. No. 81973 A.

Starting.

Compressed Air for Self-Starting Devices. Charles B. Hayward. General remarks on starting devices with an illustrated description of the device employed on the Renault cars, which has been recently improved. 800 w. Automobile—Jan. 3, 1907. No. 81420.

Tires.

What the Tire Makers Have to Offer. Describes the tire exhibit at the American Automobile Show of 1907. 2500 w. Automobile—Jan. 17, 1907. No. 81680.

Touring Cars.

The Thomas "Forty" Touring Car. Illustrated description of the motor design and accessories, the transmission, running gear, and brakes of this new car. 2000 w. Automobile—Jan. 3, 1907. No. 81418.

Transmissions.

Transmissions. Brief illustrated descriptions of new forms of transmission gear. 5500 w. Sci Am—Jan. 12, 1907. No. 81570.

Wheels.

Tires, Patent Rims, and Wheels at the Salon. W. F. Bradley. Illustrates and describes some of the dismountable rims, and some of the tires shown at the Paris Salon. 1000 w. Automobile—Jan. 3, 1907. No. 81417.

COMBUSTION MOTORS.

Alcohol.

Alcohol Engines as a Future Power. Elihu Thomson. Explains the fitness of alcohol for power purposes, showing that its properties and the conditions of use are favorable to its employment. 2000 w. Elec Wld—Jan. 5, 1907. No. 81499.

Tax-Free Alcohol. Albert P. Sy. A

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short review of the alcohol industry, giving the text of the new law removing the internal revenue tax on grain alcohol. 4000 w. Jour Fr Inst—Jan., 1907. No. 81905 D.

Gas Engines.

A Portable Engine Worked on Suction Gas. Illustrates and describes an interesting application of the suction gas producer plant, made in Germany. 500 w. Engr, Lond—Jan. 18, 1907. No. 81995 A.

The Buffalo Gas Engines. Illustrates and describes these single-acting tandem gas engines. 2000 w. Power—Feb., 1907. No. 82013 C.

1200-Horse-Power Four-Cylinder Gas-Engine. Illustrated description of a gas-engine recently built in England, for direct coupling to a large continuous-current generator. 1000 w. Engng—Jan. 11, 1907. No. 81748 A.

The Selection of a Gas Engine. A. S. Atkinson. Discusses some points in regard to the selection of power boats and the kind of engines most suited for them. 2200 w. Rudder—Jan., 1907. No. 81371 C.

Ignition.

Gas-Engine Ignition. R. H. Coombs. The present article considers primary batteries, wet and dry; the dynamo and magneto; and the storage battery. 4500 w. Rudder—Jan., 1907. Serial. 1st part. No. 81372 C.

Electric Ignition for Two-Cylinder Motors (Die elektrische Zündung be Zweizylinder-Motoren). Josef Löwy. Various arrangements of ignition apparatus compared and discussed. Ills. 1300 w. Elektrotechnik und Maschinenbau—Dec. 16, 1906. No. 81827 D.

Marine Engines.

Explosive Engines for Naval Purposes. Arthur T. Chester. Read before the Soc. of Nav. Archts. & Marine Engrs. Considers the advantages and disadvantages of these engines as applied to a man-of-war, comparing their merits with high-pressure modern steam plants. 4000 w. Naut Gaz—Jan. 17, 1907. No. 81716.

Petrol.

Some Tests of a Petrol-Engine. H. Topham and H. G. Tisdall. A report of tests made to determine the relation between the rate of consumption of petrol per brake h.-p. in the engine and the character of the spark used for igniting the cylinder mixture. 2000 w. Engng—Dec. 28, 1906. No. 81539 A.

Power.

Predetermination of Maximum Motor Power. R. Arnoux. Trans. from *Bul. Off. de la Com. Tech.* Discusses methods of determining as accurately as possible the influence of the factors that limit the maximum power output of the internal combustion motor. 3500 w. Automobile —Jan. 10, 1907. Serial. 1st part. No. 81617.

Producer Gas.

The Pressure Producer Gas Plant. Illustrates and describes the principal features. 1400 w. Ry & Engng Rev—Jan. 5, 1907. No. 81468.

Suction Gas.

Trials of Suction-Gas Plants at Derby, 1906. Abstract of a report of these trials, carried out under the auspices of the Agricultural Society of England. 4000 w. Mech Engr—Jan. 12, 1907. Serial. 1st part. No. 81730 A.

Turbines.

The Gas Turbine. René Armengaud. An illustrated discussion of these continuous combustion motors, giving practical results with actual operative machines in France. 3000 w. Cassier's Mag—Jan., 1907. No. 81781 B.

Waste Gases.

Some Considerations Affecting the Application of Waste Gases for Power Purposes. F. E. Junge. On the utilization of gas from blast furnaces, the proportion of power gas available from coke ovens, natural gas, best disposition of surplus gases, etc. 6500 w. Power—Jan., 1907. No. 81454 C.

HEATING AND COOLING.

Boilers.

Specific Rating of the Heating Surface of Heating Boilers (Die Spezifische Leistung der Heizkessel-Heizflächen). G. de Grahl. Discussion of rate of evaporation, steam and water temperatures, etc., observed in house-heating boilers. Ills. 5900 w. Gesundheits Ingenieure—Nov. 3, 1906. No. 81850 D.

Electric.

Cooking by Electricity. Putnam A. Bates. Presents the advantages of electricity for cooking, discussing the cost, and related subjects, giving an illustrated description of the electric grill in service at the Waldorf-Astoria. 2500 w. Elec Wld—Jan. 5, 1907. No. 81504.

Electric Heating. W. J. Barr. Remarks on recent progress in the use of electrical heating appliances. 800 w. Elec Wld—Jan. 5, 1907. No. 81505.

Fans.

The Fan and the Furnace. J. R. Cravath. On the use of electric fans for forced circulation in a hot-air furnace, illustrating the arrangement. 600 w. Elec Wld—Jan. 5, 1907. No. 81506.

Galvanized Iron Work for Fan Systems. G. W. Frost. Treats of methods employed in the construction of ducts and flues used with the fan systems of heating and ventilation, with other details. Ills. 600 w. Met Work—Jan. 19, 1907. Serial. 1st part. No. 81675.

Hippodrome.

The Heating and Ventilation of the

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Cleveland Hippodrome. Illustrates and describes an interesting type of downward ventilation with an auxiliary system of direct steam heating. 2000 w. Heat & Vent Mag—Jan., 1907. No. 81792.

Hot Water.

Hot Water Heating. Charles L. Hubbard. Explains the action of this system, direct heating, the capacity of a radiator, piping, etc., in the present article. Ills. 2000 w. Met Work—Jan. 5, 1907. Serial. 1st part. No. 81393.

Indirect Systems.

Temperatures for Testing Indirect Heating Systems. W. W. Macon. Read before the Am. Soc. of Heat. & Vent. Engrs. Gives values of temperatures for use in testing such systems during periods when the zero weather conditions, for which the system is designed, are not existing. 2800 w. Met Work—Jan. 26, 1907. Serial. 1st part. No. 81922.

Pipes.

Standard Sizes of Steam Pipes. James A. Donnelly. A discussion of the proper sizes of steam mains and methods of determining the velocity, quantity, etc. Tables and formulas. 2000 w. Heat & Vent Mag—Jan., 1907. No. 81793.

School Buildings.

The Ventilation of School Buildings. Thomas S. Ainge. The present article considers the essentials of good ventilation and the methods of securing them. 3300 w. Dom Engng—Jan. 12, 1907. Serial. 1st part. No. 81585.

Shops.

Heating System of the Kingsland Shops of the Delaware, Lackawanna & Western R. R. Illustrated description of the arrangements for a central station system of hot-water circulation, with combinations of direct and indirect radiation. 3000 w. Eng Rec—Jan. 12, 1907. No. 81578.

Steam.

Points on the Design of a High-Pressure Superheated Steam Heating System, Combined with a Light and Power Plant. Frank Koester. Outlines some of the more important points, as employed in European practice, to be taken into consideration in designing such a plant. Ills. 2200 w. Heat & Vent Mag—Jan., 1907. No. 81794.

Transmission.

Calculation of Heat Transmission in Europe and the U. S. (Die Wärmetransmissionsberechnung in Amerika und bei uns). Bronislaw Biegeleisen. A comparison of the formulæ employed by heating engineers for various buildings. Diagrams and tables. Serial. 2 parts. 6000 w. Gesundheits Ingenieure—Nov. 17 and 24, 1906. No. 81854 each D.

Valves.

Steam Passage in Low Pressure Steam Heating Valves (Über den Dampfdurchgangdurch Regulierentile in Niederdruckdampfheizungen). Herr Zyka. Ills. 600 w. Gesundheits Ingenieure—Oct. 27, 1906. No. 81852 D.

HYDRAULICS.

Centrifugal Pumps.

Construction of Centrifugal Pumps. William G. Gass. Abstract of a paper read before the Manchester Assn. of Engrs. Divides centrifugal pumps into four general types, considering each in detail. Ills. 3000 w. Mech Engr—Jan. 5, 1907. Serial. 1st part. No. 81633 A.

The Installation of Centrifugal Pumps. William O. Webber. Gives information in regard to the proper manner of installing centrifugal pumps, and concerning their capabilities. 1500 w. Eng News—Jan. 10, 1907. No. 81559.

Actual Efficiencies of Fans and Centrifugal Pumps. (Uber die Wirkungsgrade von Ventilatoren und Zentrifugalpumpen). L. Schütt. Discussion of performances. Diagrams. 2300 w. Zeitschrift für das Gesamte Turbinenwesen—Nov. 10, 1906. No. 81843 D.

Centrifugal Pumps at the Milan Exposition, 1906. (Die Internationale Ausstellung in Mailand, 1906). W. A. Müller. Describes and illustrates centrifugal pumps, both direct and belt driven. Illus. 2000 w. Zeitschrift für das Gesamte Turbinenwesen—Nov. 10, 1906. No. 81844 D.

Electric Pumping.

An Electric Graving Dock Pumping Plant at Hong Kong. Illustrated description of an interesting electrical equipment recently installed, including a pair of motor driven twin parallel pumps of the hirizontal type, a vertical electric centrifugal pump, and an electrical air pump, for exhausting the air from the two main pumps. 600 w. Int Marine Engng—Feb., 1907. No. 81760 C.

Pump Valves.

Pump Discharge Valves. (Versuche zur Bestimmung der ausflusziffer bei Pumpenventilen). R. Baumann and L. Klein. Efficiency of various proportions for pump discharge valves is treated in detail. Illus. 4500 w. Zeitschrift Des Vereines Deutsches Ingenieure—Dec. 29, 1906. No. 81839 D.

MACHINE WORKS AND FOUNDRIES.

Boilers.

How to Lay Out a Tubular Boiler. H. S. Jeffery. Gives a description, as complete as possible, of the lay out of an ordinary tubular boiler, using several different formulæ to show how each joint is found. 3000 w. Boiler Maker—Jan., 1907. Serial. 1st part. No. 81353.

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Boiler Works.

Muskegon Boiler Works. Brief illustrated description of boiler shops in Michigan. 800 w. Boiler Maker—Jan., 1907. No. 81351.

Car Axles.

The Art of Manufacture of Railway Car Axles. Henrik V. von Z. Loss. Describes the method used in making the standard axle of the present, and their tools, enumerating the objections to the method and steps taken to overcome the difficulties. Ills. 7000 w. Jour Fr Inst Jan., 1907. No. 81902 D.

Castings.

An Interesting Process for Avoiding Sponginess in Heavy Steel Castings. Illustrated description of a process based upon the use of a deadhead or sullage piece, which is employed successfully at the Gutehoffnungschütte works for castings weighing up to 60 tons. 1000 w. Sci Am—Jan. 15, 1907. No. 81379.

Making Unusual Castings. Walter J. May. Suggestions for successful work in various kinds of castings. 1400 w. Prac Engr—Jan. 11, 1907. No. 81728 A.

The Production of Malleable Castings and Their Application in Machine Construction. Dr. Richard Moldenke. Summarizes the process of making malleable cast iron and states precautions necessary to secure satisfactory results. 2200 w. Cassier's Mag—Jan., 1907. No. 81783 B.

Chasing.

The Hartness Turret Chasing Tool. Illustrates and describes an automatic turret screw chasing tool for use on the flat turret lathe. 1200 w. Ir Age—Jan. 31, 1907. No. 82014.

Cutting Metals.

The Art of Cutting Metals. Discussion of the paper by F. W. Taylor, on the above subject. 6000 w. Pro Am Soc of Mech Engrs—Jan., 1907. No. 81389.

Cylinders.

Air-Cooled Gas-Engine Cylinder Construction. Hugh Dolnar. Remarks on the earliest efforts to cool the cylinders, and illustrates and describes the practice of the Corbin automobile shops, New Britain, Conn. 2000 w. Am Mach—Vol. 30. No. 2. No. 81552.

Patternmaking and Molding of Air-Cooled Gas-Engine Cylinders. E. F. Lake. Illustrated description of methods for the different styles. 3000 w. Am Mach—Vol. 30. No. 1. No. 81482.

Drilling.

A 32-Spindle Ring Drilling Machine. Hugh Dolnar. Half-tone and construction drawing, with description. 1000 w. Am Mach—Vol. 30. No. 1. No. 81486.

Electric Driving.

An Electrically-Driven Cycle Factory. Describes the electrical equipment of a factory in Birmingham, Eng., where sheet steel has entirely displaced castings, and the operations necessary for the transformation of blanks into the desired forms are carried out chiefly in presses; the process is explained. 1400 w. Engr, Lond—Jan. 11, 1907. Serial. 1st part. No. 81752 A.

Electric Furnace.

Electrically Heated Annealing and Hardening Furnace. Illustrated description of a German furnace which assures perfect control of temperature. 900 w. Am Mach—Vol. 30. No. 1. No. 81481.

Equipment.

A Model Electrical Machine Shop Equipment. F. M. Feiker. Illustrated description of new shops in Atlanta, Ga., showing the adaptation of the electric motor to machine-tool work. 2200 w. Elec Rev, N Y—Jan. 12, 1907. No. 81594.

Factory.

The U. S. Naval Gun Factory at Washington, D. C. H. J. Kennedy. Gives the history and an illustrated description of these works and their equipment. 6000 w. Am Mach—Vol. 30. No. 3. Serial. 1st part. No. 81665.

Foundry.

Foundry Mixtures. Bradley Stoughton. Read before the Pittsburg Found. Assn. Considers the difference between iron and steel castings, shrinkage, porosity, workability, strength, etc. Ills. 3000 w. Foundry—Jan., 1907. No. 81390.

Galvanizing.

Cold Galvanizing for Iron and Steel. A. Frederick Collins. States the advantages and cost as compared with the hot process. 1000 w. Sci Am—Jan. 26, 1907. No. 81928.

Gear Cutters.

Making Small Relieved Gear Cutters in the Sloan & Chace Shops. Illustrates and describes the methods used in these shops. 3000 w. Mach, N Y—Jan., 1907. No. 81413 C.

A European Bevel Gear Generating Machine. Illustrates and describes a bevel gear planing machine built at Mulhouse, Alsace, which shows features of considerable interest. 1600 w. Mach, N Y—Jan., 1907. No. 81414 C.

Gears.

A Skew Bevel Gear Model. John F. Arthur. Gives model and description. 1200 w. Mach, N Y—Jan., 1907. No. 81412 C.

Design of an All Gear Drive for a Lathe or Similar Tool. W. S. Gille. Presents a solution of a typical example. Ills. 1400 w. Sib Jour of Engng—Jan., 1907. No. 81915 C.

Grinder.

The Dahl Automatic Drill Grinder.

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An illustrated description of an automatic machine for sharpening twist drills. 1000 w. Ir Age—Jan. 10, 1907. No. 81513.

Hardening.

The Hardening of Steel in an Electrically Heated Bath. Brief illustrated description of an electrically heated furnace for hardening and annealing steel, giving some of the results. 1000 w. Ir Age—Jan. 3, 1907. No. 81363.

Ideals.

Machine Shop Ideals in Foundry Operation. W. W. McCarter. Discusses economy in foundry practice and gives suggestions helpful in modernizing an old-fashioned plant. 3000 w. Engineering Magazine—Feb., 1907. No. 81893 B.

Inspection.

The Relation of Inspection to Money-Making Shop Management. A. D. Wilt, Jr. An explanation of the possibilities of a well-planned system of inspection, what it aims to accomplish, and some plans of inspection. 5000 w. Engineering Magazine—Feb., 1907. No. 81895 B.

Jig.

A Boring and Drilling Jig and Its Operations. H. F. Noyes. Illustrated description. 500 w. Am Mach—Vol. 30. No. 1. No. 81487.

Lathes.

Driving-Wheel Tire Lathe. Illustrated description of a heavy chucking lathe for driving wheels, having a capacity of from six to ten pairs of tires per ten-hour day. 1200 w. Engr, Lond—Dec. 28, 1906. No. 81548 A.

Fly-Wheel Boring, Turning, and Bossing Lathe. Illustration and brief description of a lathe for dealing with gas-engine and other fly-wheels, capable of finishing a fly-wheel at one setting, six tools being in operation at once. 500 w. Engr, Lond—Jan. 11, 1907. No. 81755 A.

Locomotive Works.

The Locomotive Works of Beyer, Peacock, and Co., Limited. An illustrated article giving the history of the development of these English works. 2700 w. Engng—Jan. 4, 1907. Serial. 1st part. No. 81648 A.

Machine Tools.

Some Early Continental Machine Tools. Drawings and descriptions which illustrate the early history of the art of machine tool making on the Continent. 2200 w. Engr, Lond—Jan. 4, 1907. No. 81655 A.

Malleable Castings.

Reverberatory Furnace for the Production of Malleable Castings. (Die Verwendung des Flammofens in der Giesserei, insbesondere zur Schmelzung von schmiedbarem Guss). Geilenkirchen-Hörde. Description of various forms of furnace used in England, Germany and the U. S.. Illus. Serial. 3 parts. 7400 w. Stahl und Eisen—Jan. 2, 9 and 16, 1907. No. 81808 each D.

Milling Machinery.

Up-to-Date Milling Machinery. A. Bryant Symons. Information concerning recent practice. Ills. 1600 w. Prac Engr—Jan. 4, 1907. Serial. 1st part. No. 81630 A.

The Kennedy Universal Plate Mill. Illustrates and describes a universal mill, embodying a number of new devices, recently installed at Johnstown, Pa. 800 w. Ir Age—Jan. 3, 1907. No. 81361.

An Extra-Heavy Slab-Milling Machine. Illustrates and describes a milling machine of great weight and power, and of somewhat novel design. 1000 w. Am Mach—Vol. 30. No. 2. No. 81553.

Molding.

Twelve Lessons on Raking Moldings. William Neubecker. The first of a series of twelve articles describing the method of developing the various raking moldings arising in practical work. Ills. 800 w. Met Work—Jan. 5, 1907. Serial. 1st part. No. 81395.

Molding a Toggle Press Body in Green Sand. R. H. Palmer. Illustrated detailed description of the making of a casting requiring 30,000 pounds of iron to pour it. 2500 w. Am Mach—Vol. 30. No. 5. No. 82018.

Molding Cast Steel Truck Bolsters. H. J. McCaslin. Drawings and description of method used. 2400 w. Foundry—Jan., 1907. No. 81392.

Molding Machine.

The Gravity Molding Machine. A new type of molding machine, which accomplishes the ramming of the mold by gravity, is illustrated and described. 800 w. Ir Age—Jan. 10, 1907. No. 81514.

Patterns.

The Development of a Screw Propeller from the Patternmakers Standpoint. Carl H. Clark. Considers the development of the propeller blade from the known dimensions and the putting it into such shape that the pattern may be made from it. Ills. 1800 w. Foundry—Jan., 1907. No. 81391.

Power.

The Choice of Motive Power for the Workshop. R. E. Mathot. This second article gives a study of the comparative running costs of steam, gas, and oil engines under operative conditions. 3500 w. Engineering Magazine—Feb., 1907. No. 81896 B.

Profit-Making.

Profit Making in Shop and Factory Management. C. U. Carpenter. This second article of a series deals with the practical working of the committee system showing its success. 5000 w. Engineering Magazine—Feb., 1907. No. 81891 B.

We supply copies of these articles. See page 999.

Shops.

The Ferracute Machine Company's Plant. Illustrated description of fine modern machine works of fireproof construction recently completed at Bridgeton, N. J. 3500 w. Ir Age—Jan. 24, 1907. No. 81764.

The Fulton Foundry and Machine Works. Illustrated description of new shops at Kirkwood, Ga., which are modern in construction and equipment. 2000 w. Ir Age—Jan. 10, 1907. No. 81515.

The Works of the Western Electric Company of America. Illustrated detailed description of the Hawthorne shops, near Chicago, where dynamos and motors of all sizes, electrical machinery in general, telephones, electric light apparatus, electric cables and other specialties are made. 2700 w. Engr, Lond—Dec. 28, 1906. No. 81542 A.

Shrinkage.

A Universal Shrink Rule. F. W. Barrows. Describes this new shrink rule, explaining its use. Ills. 2000 w. Am Mach—Vol. 30. No. 1. No. 81484.

Standards.

Errors in and Limits of Workmanship. Conclusions from two comprehensive reports of the British Engineering Standards Committee. 1200 w. Am Mach—Vol. 30. No. 1. No. 81485.

Tempering.

Tempering Steel with Cyanide—Some Results Obtained by Its Use, and Some Instances Where It Should Not Be Employed. E. R. Markham. 1200 w. Am Mach—Vol. 30. No. 2. No. 81554.

Thread Tools.

Thread-Cutting Tools—Methods of Making and Using. R. A. Almond. Illustrates and describes holders and fixtures for single-pointed thread tools and chasers, grinding and shaping devices, etc. 3200 w. Am Mach—Vol. 30. No. 1. No. 81483.

Trucks.

Steel Truck Construction and History of Steel. W. E. Symons. Briefly reviews the iron and steel industry, explaining the various processes for making steel, tracing historically the evolution of trucks and giving much related information. General discussion. Ills. 10000 w. Pro S & S-W Ry Club—Nov., 1906. No. 81777 E.

Wheels.

Weldless Pressed Spoke Car Wheels (Nahtlos gepresste Speichenräder für Eisenbahnfahrzeuge, System Ehrhardt; ihre Herstellung und ihre Eigenschaften im Vergleich zu gewalzten Schreibenrädern und geschweissten Speichenrädern). D. von Hippel. Method of manufacture described, and performance in service compared with other kinds. Ills. 3500 w. Glaser's Annalen—Dec. 15, 1906. No. 81817 D.

Wire.

Wire Drawing: The Second Step in a Useful Art. W. W. Gibbs. An account of the invention of the multiple die system. Ills. 5500 w. Ir Age—Jan. 3, 1907. No. 81364.

Works.

The Laying Out of New Works. Considers the general principles to be observed in laying out up-to-date works. The site, buildings, power, lighting, heating and ventilation, driving and arrangement of machinery, handling of material, etc., are discussed. Ills. 4000 w. Engr, Lond—Jan. 18, 1907. Serial. 1st part. No. 81990 A.

MATERIALS OF CONSTRUCTION.

Electric Machinery.

Materials for Electric Machinery. J. Epstein. Read before the Inst. of Elec. Engrs. Information concerning the selection and testing of materials for the construction of electric machinery, and of the complete electric machines. 6000 w. Engng—Jan. 19, 1907. Serial. 1st part. No. 82001 A.

Finish.

The Production of the Bower-Barff Finish. An illustrated detailed description of this black finish for iron and steel and its modifications, giving cost. 3000 w. Brass Wld—Jan., 1907. No. 81937.

Steel.

Brittleness of Mild Steel. Abstract of a report by C. E. Stromeyer, to the Manchester Steam Users' Assn. Discusses the cause of brittleness, the effect of treatment, etc. 2000 w. Sci Am Sup—Jan. 12, 1907. No. 81571.

MEASUREMENT.

Diagrams.

Straight Line Expansion Diagrams. An explanation of the method of laying out expansion curves, and straight-line diagrams. 2000 w. Power—Jan., 1907. No. 81463 C.

A Study of the Zeuner Slide-Valve Diagram. E. S. Hawkins. Considers Zeuner's diagram in detail. 3000 w. Power—Jan., 1907. No. 81456 C.

Dynamometer.

Modern Water-Wheel Testing. Brief illustrated description of the Alden Absorption Dynamometer for testing wheels of large powers, and its use. 1500 w. Jour Worcester Poly Inst—Jan., 1907. No. 81778 C.

Kinematic Apparatus.

Newman's Kinematic Apparatus for the Study of Mechanism. Illustrates and describes apparatus designed to facilitate the investigation and illustrate the properties of valve gears, straight-line motions, etc. 2500 w. Engng—Dec. 28, 1906. No. 81534 A.

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Pyrometer.

Uehling Pyrometer Improvement. Illustrates and describes the development of a multiple recording pneumatic pyrometer. 1200 w. Ir Age—Jan. 10, 1907. No. 81516.

Strobograph.

The Strobograph, an Apparatus for Tracing the Curves due to Periodic Oscillations (Der Strobograph, eine Vorrichtung zum Aufzeichnen von Pendeldiagrammen). G. Wagner. Description of a device for photographing the periodic changes of harmonic vibrations. Ills. 3300 w. Zeitschrift Des Vereines Deutscher Ingenieure—Dec. 8, 1906. No. 81826 D.

POWER AND TRANSMISSION.

Air Compressors.

Theory of Operation of Air Compressors (Die Wirkungsweise der Pressluftpumpen). L. Darapsky and F. Schubert. Comprehensive discussion. Ills. Serial. 2 parts. 6600 w. Zeitschrift Des Vereines Deutscher Ingenieure—Dec. 22 and 29, 1906. No. 81831 each D.

Clearance in a Compressor, and Its Relation to Volumetric Efficiency. D. W. Hering. A mathematical discussion. 1500 w. Compressed Air—Jan., 1907. Serial. 1st part. No. 81791.

Belts.

Shop Belting Practice on the Santa Fé. Gives the specifications and repairmen's rules and instructions drawn up by Mr. H. Emerson, which have given great improvement in shop belting practice. Ills. 3000 w. R R Gaz—Jan. 25, 1907. No. 81923.

Clutches.

The Principles of Friction Clutches. Herbert Aughtie. An analysis of the forces of action. 1500 w. Mech Engr—Dec. 29, 1906. Serial. 1st part. No. 81521 A.

Coal Hoist.

A 40-Ton Hydraulic Coal Hoist. Illustrated description of a hoist for the new docks at Middlesbrough. 500 w. Engr, Lond—Jan. 4, 1907. No. 81661 A.

Coolers.

The Antecooler, the Intercooler, and the Aftercooler. Frank Richards. Presents the advantages gained by the use of the intercooler. 1800 w. Compressed Air—Jan., 1907. No. 81790.

Cost.

A Comparison of the Cost of Power as Generated by Different Types of Steam Engines. W. M. Wilson. An endeavor to determine the relative merits of different types of engines under different assumed conditions. 3500 w. Power—Jan., 1907. No. 81455 C.

See also Street Railways.

Cranes.

Modern Harbor Cranes. Brief illustrated descriptions of types built in Europe, and their methods of operation. 800 w. Elec Wld—Jan. 26, 1907. No. 81943.

Electric.

The Dunston-on-Tyne Flour Mill. Illustrated description of the electrical working of a large flour mill. 2200 w. Elect'n, Lond—Jan. 4, 1907. No. 81642 A.

Elevator.

The Hydraulic Elevator. William Baxter, Jr. Gives comparison of the "pushing" and "pulling" types of horizontal-cylinder machines, describing the general arrangements of low-pressure systems. Ills. 3000 w. Power—Feb., 1907. No. 82012 C.

Defective and Dangerous Features in Elevator Operation. Reginald Pelham Bolton. Calls attention to features needing correction to assure greater safety and improved service. 1500 w. Engineering Magazine—Feb., 1907. No. 81894 B.

Handling.

Handling Equipment for Structural Plants. George P. Thomas. Illustrates and describes hoists, cranes and like machinery designed for this work. 2000 w. Ir Age—Jan. 24, 1907. No. 81765.

Niagara.

Niagara Power at the Lackawanna Steel Plant. John C. Parker. Brief illustrated description of the installation for transforming and distributing this power in the West Seneca works, with discussion of certain features. 3500 w. Elec Jour—Jan., 1907. No. 81787.

Power Extensions at Niagara. Illustrates and describes the recent developments of the oldest power concern at Niagara—the Niagara Falls Hydraulic Power and Manufacturing Co. 1500 w. Engr, Lond—Jan. 4, 1907. No. 81657 A.

Power Plant.

Power Plant of the American Museum of Natural History, New York. Illustrated detailed description of a plant of unusual interest, which will also be susceptible of utilization for exhibition purposes. 2500 w. Eng Rec—Jan. 19, 1907. No. 81721.

The United States Bureau of Engraving and Printing. Charles A. Blatchley. An illustrated detailed description of its power plant and mechanical equipment. 4500 w. Ir Age—Jan. 3, 1907. No. 81366.

The Power Plant of the Metropolitan Life Building, New York. Illustrates and describes a new plant designed to furnish heat, light, and power for use of the largest office-buildings in the world. There is a boiler plant of nearly 2,300 h.-p., an electrical equipment of 1,100 k. w. capacity, the machinery for 44 high-pressure elevators, and heating, ventilating, and other auxiliary appara-

tus. Illus. 4000 w. Eng Rec—Jan. 26, 1907. No. 81949.

Power Plant of the Kingsland Shops of the Delaware, Lackawanna & Western R. R. Illustrated detailed description of the power house, coal and ash handling systems, and underground smoke flue construction, the steam generating, electrical, and air compressor equipment, etc. 7000 w. Eng Rec—Jan. 5, 1907. No. 81492.

The Steam Plant of the Wood Worsted Mill. Illustrated detailed description of a plant for a very large textile mill in Massachusetts, discussing the relation of heat used for power production to that used for heating and mill processes. 4000 w. Power—Feb., 1907. No. 82010 C.

The Planning and Construction of the Power Plant. A. E. Dixon. The seventh article of this series deals with gas engines and gas generators and their applications to large installations. Ills. 3000 w. Engineering Magazine—Feb., 1907. No. 81892 B.

Rope Drives.

Rope Drives—Various Methods of Arranging Ropes on the Sheaves. R. Hoyt. Different systems are briefly discussed. 1200 w. Power—Jan., 1907. No. 81458 C.

Horsepower Transmissible by Manila Ropes. Frank Wackermann. Gives a table of horsepower transmitted by manila ropes, considering the effects of centrifugal force, so that the tension is constant at all speeds, and the tension on the slack side. 1000 w. Ir Age—Jan. 17, 1907. No. 81664.

Rope-Way.

Aerial Rope-Way in Argentina. An account of a rope-way constructed under great difficulties, in the Andes, for the purpose of developing valuable mines. 1000 w. Engr, Lond—Dec. 28, 1906. No. 81546 A.

Timber Conveyor.

Apparatus for Conveying and Piling Timber. Illustrated description of a special type of conveyor for unloading timber rapidly. 800 w. Engr, Lond—Jan. 18, 1907. No. 81994 A.

Turbines.

Turbine Installation at Munich (Die Turbinenahlage der Isarwerke bei München). Andreas Stamm. Water-power turbines driving electric generators at the "Isarwerke." Ills. Serial. 2 parts. 1700 w. Zeitschrift für das Gesamte Turbinenwesen—Dec. 20, 1906, and Jan. 10, 1907. No. 81848 each D.

Fink Method of Turbine Regulation (Regulierwiderstand bei Finkscher Turbinenregulierung). R. Camerer. Mode of controlling water turbines described and discussed. Ills. 1400 w. Zeitschrift Des Vereines Deutscher Ingenieure—Dec. 15, 1906. No. 81828 D.

STEAM ENGINEERING.

Auxiliaries.

Boiler Auxiliaries. Illustrates and describes safety devices and regulators, considering their care. 6000 w. Engr, U S A—Jan. 1, 1907. No. 81428 C.

Boilers.

Care and Management of Boilers. I. Deterioration of Boilers. E. S. Hawkins. Considers corrosion, overheating, scale, grooving, etc. II. Routine of the Boiler Room. A. J. Albright. Discusses methods of caring for, cleaning, repairing, firing, and operating boilers. 6200 w. Engr, U S A—Jan. 1, 1907. No. 81436 C.

Boiler Installation at the Nuremberg 1906 Exposition. (Die Dampfkesselanlarge in der Bayerischen Jubiläums Landesausstellung Nürnberg 1906). J Schmidt. Detailed description of boiler plant. Illus. Serial. 2 parts. 5900 w. Elektrotechnik und Maschinenbau—Nov. 18 and 25, 1906. No. 81819 each D.

Classification of Boilers. Illustrates and describes various constructions and types, stating the advantages of each. 3000 w. Engr, U S A—Jan. 1, 1907. No. 81423 C.

Details of Boiler Construction. Discusses the materials suitable for use, form, proportion and arrangement of parts. 8000 w. Engr, U S A—Jan. 1, 1907. No. 81425 C.

Power of Boilers. Considers the meaning of power in relation to boilers, the horse-power rating, rate of evaporation for a given power, etc. 3000 w. Engr, U S A—Jan. 1, 1907. No. 81424 C.

Water-Tube Boilers. Brief illustrated descriptions of many types. 17000 w. Engr, U S A—Jan. 1, 1907. No. 81426 C.

Principles of the Steam Boiler. Judson H. Boughton. Explains the purpose of the boiler, the properties of steam, and the energy handled. 1500 w. Engr, U S A—Jan. 1, 1907. No. 81421 C.

Proportions of Scotch Boilers. Carl H. Clark. Information concerning tie proper size and design of a boiler for any given purpose. 1400 w. Boiler Maker—Jan., 1907. No. 81352.

Special Types of Fire-Tube Boilers. Brief illustrated descriptions of many types. 2000 w. Engr, U S A—Jan. 1, 1907. No. 81427 C.

Chimneys.

Chimney Design. Considers types of chimney, their construction and draft power. 3300 w. Engr, U S A—Jan. 1, 1907. No. 81433 C.

Condenser.

The Barometric Condenser. An explanation of its principles and of where the energy comes from, with illustrated descriptions of simpler types. 3300 w. Power—Jan., 1907. Serial. 1st part. No. 81453 C.

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Draft.

Mechanical Draft Systems. Explains the principles and advantages of artificial draft, giving illustrated description of details of installations. 2000 w. Engr, U S A—Jan. 1, 1907. No. 81434 C.

Economy.

Fuel Economy. H. B. Maxwell. Remarks on points to be considered to secure economy with a modern steam plant. 1500 w. Elect'n, Lond—Dec. 28, 1906. No. 81531 A.

See also Electrical Engineering, Generating Stations.

Engines.

Engines with Lentz Valves for the Steamship "Rance." This cargo-boat was fitted with superheated-steam and poppet-valve engines and the results obtained compared with a sister ship, the Garonne, fitted with ordinary type of engine, without superheater. Ills. 1500 w. Engng—Jan. 18, 1907. No. 81998 A.

Fuels.

Burning Bituminous Slack and Lignites. George P. Hutchins. Discusses the waste from firing soft coals by hand, and aims to show that mechanical stokers provide an efficient method of burning cheap fuels, and that the saving effected will quickly pay for the expense of installation. Ills. 2500 w. Elec Wld—Jan. 5, 1907. No. 81511.

Furnaces.

Proportions and Details of Furnaces and Grates. Explains the chemical process of combustion, calorimeters, smoke consuming devices, etc. Ills. 3000 w. Engr, U S A—Jan. 1, 1907. No. 81430 C.

Special Furnaces and Grates. Illustrated descriptions of several special systems are given, and of some refractory materials for furnace linings. 7500 w. Engr, U S A—Jan. 1, 1907. No. 81431 C.

Generation.

Generation of Steam. An illustrated article considering the principles governing the application of heat to the evaporation of water, and related matters. 2000 w. Engr, U S A—Jan. 1, 1907. No. 81422 C.

Indicator.

The Continuous Indicator for Rolling-Mill Engine Work. Robert L. Streeter. Considers the points a good indicator should possess for this work, and the use of the continuous indicator, giving diagrams. 2500 w. Power—Jan. 1, 1907. No. 81457 C.

Oily Waters.

Oily Waters and Their Treatment. Albert A. Cary. Considers methods of separating oil from the steam and from the water of condensation. Ills. 3000 w. Heat & Vent Mag—Jan., 1907. No. 81795.

Packing.

Fitting the High-Pressure Cylinder of an American Ball Engine with a Special Metallic Packing. William Kavanagh. Illustrates and describes a difficult application of metallic packing. 1200 w. Power—Jan., 1907. No. 81460 C.

Regulation.

Speed Regulation of Engines. G. James Wells. Read before the Manchester Assn. of Engrs. Considers the actual causes of variation of the turning moment of reciprocating engines, showing the effects have a periodic character. 4400 w. Mech Engr—Jan. 19, 1907. No. 81978 A.

Settings.

Settings for Boilers. Illustrates and describes forms of settings, methods of support, and amounts of materials needed. 2000 w. Engr, U S A—Jan. 1, 1907. No. 81429 C.

Smoke Prevention.

Timmis Smoke and Spark Consuming System. Illustrates and describes an apparatus for forcing air in the front of the fire box immediately below the brick arch. 500 w. R R Gaz—Jan. 25, 1907. No. 81924.

Stokers.

Mechanical Stokers. Illustrated descriptions of various types. 4500 w. Engr, U S A—Jan. 1, 1907. No. 81432 C.

Automatic Stokers. (Automatische stookinrichtingen). J. De Kuyser. Description and discussion of service tests of several types in use in Europe. Illus. Tables. 5400 w. De Ingenieur—Nov. 17, 1906. No. 81856 D.

Stoking.

Is Machine Stoking Economical? A. W. Bennis. Abstract of a paper read before the Keighley Assn. of Engrs. Gives particulars of relative cost of mechanical and hand firing, discussing some of the objections advanced to the use of machine firing. 1300 w. Aust Min Stand—Dec. 19, 1907. No. 81968 B.

Superheating.

Superheaters and Superheating Boilers. Brief illustrated descriptions of types of superheaters, explaining their advantages. 2500 w. Engr, U S A—Jan. 1, 1907. No. 81435 C.

Thermodynamics.

Steam at High Pressures and Temperatures. Considers the properties of steam at high temperatures, and some errors in calculations submitted, in the present article. 2300 w. Engr—Jan. 4, 1907. Serial. 1st part. No. 81647 A.

Turbines.

Notes on Turbine Erection and Operation. Considers features in connection with the erection of turbines, balancing, starting, vibration, lubrication, etc. 2500 w. Elec Rev, Lond—Dec. 28, 1906. No. 81524 A.

The Largest Steam Turbine Power-

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Plant in Europe. Franz Koester. Illustrated description of the St. Denis Station of the Société d' Electricite de Paris, 1400 w. Power—Feb., 1907. No. 82011 C.

Steam Turbines at the Nuremberg 1906 Exposition (Die Dampfturbinen auf der Bayerischen Landesausstellung Nürnberg 1906). C. W. Gesell. Comprehensive description of various makes of turbines exhibited. Illus. 2800 w. Zeitschrift für das Gesamte Turbinenwesen—Oct. 30, 1906. No. 81842 D.

The Governing of Multiple Vane Steam Turbines (Über die Regelung mehrstufiger Dampfturbinen). H. Jansson. Comprehensive article comparing the salient features of the leading turbines now in use. Illus. Serial. 4 parts. 9300 w. Zeitschrift für das Gesamte Turbinenwesen—Nov. 20, Dec. 10, 20 and 29, 1906. No. 81845 each D.

Practical Troubles with Steam Turbines. E Russell. Discusses cases of stripping the blades, improperly designed cylinders, deposits and methods of cleaning. 1200 w. Power—Jan., 1907. No. 81459 C.

Application of Steam Turbines to the Propulsion of Vehicles (Beitrag zur Frage der Verwendung von Dampfturbinen für den Antrieb von einzelnen Eisonbahnwagen an Stelle von Elektromotoren). Hans Holzwarth. Ills. Serial. 2 parts. 2400 w. Zeitschrift für das Gesamte Turbinenwesen—Nov. 20 and 30, 1906. No. 81847 each D.

Rotation Losses in Steam Turbines. Hans Holzwarth. With chart showing the power required to overcome the windage of blades of various heights when running at various velocities in steam of various densities. 1500 w. Power—Jan., 1907. No. 81462 C.

MISCELLANY.

Aeronautics.

Aeroplanes and Propellers. Some valuable suggestions given by Patrick Alexander in a lecture before the Aero Club. 2500 w. Auto Jour—Dec. 29, 1906. No. 81519 A.

The de la Vaulx Airship. Illustrated detailed description. 1000 w. Sci Am Sup—Jan. 5, 1907. No. 81381.

Cotton Mills.

Electrically-Driven Cotton Mills. Information in regard to the change of power in many of the mills in Lancashire, with editorial on the new mills, equipped with the most modern machinery. Ills. 2700 w. Engng—Jan. 11, 1907. No. 81746 A.

Engineering in Cotton Mills. Views of new mills under construction in England, with details of the engines and appliances. 700 w. Engr, Lond—Dec. 28, 1906. No. 81544 A.

Safeguards for Cotton Machinery. From a lately issued Home Office report, by H. S. Richmond, calling attention to dangerous parts of machinery used, and illustrating protective devices which should be used. 2000 w. Engng—Jan. 4, 1907. No. 81649 A.

1906 Review.

Mechanical Engineering. A review of the year confined principally to steam machinery. 6500 w. Engr, Lond—Jan. 4, 1907. No. 81658 A.

Rotating Disk.

Theory of Rotating Disks. (Zur Theorie der rotierenden Scheiben). J. Illeck. Mathematical treatment of the subject. Diagrams. 3300 w. Zeitschrift Des Osterreichischen Ingenieure und Architekten Vereines—Dec. 28, 1906. No. 81805 D.

Sugar.

Machinery of a Beet Sugar Refinery. (Inleiding tot het bezoek aan de fabriek van de Maatschappiz voor Landbouwen Beetwortelsuiker-industrie te Zevenbergen) J. C. Dijxhoorn. Comprehensive description of a Dutch beet sugar plant. Ills. 4800 w. De Ingenieur—Nov. 10, 1906. No. 81855 D.

Turbo-Compressor.

Centrifugal Air Compressor (Turbokompressor, Bauart Rateau und Armangaud). Alfred Barbezat. Description of high speed centrifugal air compressor. Illus. 3000 w. Zeitschrift für das Gesamte Turbinenwesen—Dec. 29, 1906. No. 81846 D.

MINING AND METALLURGY

COAL AND COKE.

Coal.

Coal in the United States and Other Countries. Edward W. Parker The production, and the development of the coal mining industry are considered. 3000 w. Mfrs Rec—Jan. 3, 1907. No. 81409.

Coke Oven.

New Type of Coke Oven (Die Neusten Koksöfen von Dr. Th. von Bauer Nebst Veraldevorrichtung). O. Simmersbach. Description of an oven lately built near Dusseldorf from designs by von Bauer. Ills. 2800 w. Stahl und Eisen—Dec. 15, 1906. No. 81806 D.

Coking.

The Zeigler Process for Coking Peat. Otto K. Zwingenberger. Illustrates and describes a new method being success-

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fully used in Germany. 1500 w. Eng & Min Jour—Jan. 19, 1907. No. 81698.

Colliery.

The Hutton Colliery. Prof. James Tonge. An illustrated description of the large and well-equipped Atherton pits of this English colliery, situated in the Lancashire coal field. 5500 w. Mines & Min—Jan., 1907. No. 81397 C.

Explosives.

Explosives in Coal Mines. Report of the Departmental Committee on the use of bobbinite. 6500 w. Col Guard—Jan. 18, 1907. No. 81989 A.

Fossils.

The Value of Fossil Mollusca in Coal-Measure Stratigraphy. John P. Stobbs. Supplementary to an earlier paper. Shows the value of these mollusca in proving where a boring had reached, in proving faults, testing their magnitude, etc. Discussion. 3000 w. Col Guard—Jan. 18, 1907. No. 81988 A.

Montana.

Montana Coal and Lignite Deposits. J. P. Rowe. An illustrated article describing the location and character of the fuel deposits of this state. 4500 w. Min Wld—Jan. 19, 1907. No. 81714.

Pneumatic Tools.

Pneumatic Coal-Boring Machines and Tools. W. Lynch. Read before the Inst. of Min. Engrs. Brief review of the classes of pneumatic tools used for this work and the results. 1400 w. Min Rept—Jan. 24, 1907. No. 82008.

Screening.

Coal Screening Plant for the Cawdor and Garnant Colliery Company. Drawings and description of the arrangement of a coal screening, crushing, and washing plant, capable of dealing with 40 tons of coal per hour. 1000 w. Ir & Coal Trds Rev—Dec. 28, 1906. No. 81549 A.

United States.

Coal Mining in the United States. A Review of the technology, markets, and history of the industry in 1906. 11000 w. Eng & Min Jour—Jan. 5, 1907. No. 81479.

Ventilation.

Ventilation in Flat Coal Seams. A. H. Stow. A technical consideration of modern mine ventilation with reference to economy and efficiency in non-gaseous, low seams. 2500 w. Eng & Min Jour—Jan. 26, 1907. No. 81960.

COPPER.

Acid-Copper.

The Care of Acid-Copper Solutions. Suggestions for keeping this solution in good working order for electroplating. 700 w. Brass Wld—Jan., 1907. No. 81939.

Arizona.

The Production of Copper in Arizona During 1906. James Douglas. Gives an account of operations in the various districts, and the output of the chief producers. 1200 w. Eng & Min Jour—Jan. 26, 1907. No. 81961.

Australia.

A New Copper Field in Australia. John Plummer. An account of the discovery of a promising mine. 800 w. Min Wld—Jan. 5, 1907. No. 81466.

California.

Some Notes on Greenwater. Edward R. Zalinski. An illustrated account of this new copper district of California, its developments and prospects. 4000 w. Eng & Min Jour—Jan. 12, 1907. No. 81600.

The Copper of Shasta County, California. Donald F. Campbell. The present article describes the geology of the region. 2000 w. Min & Sci Pr—Jan. 5, 1907. Serial. 1st part. No. 81608.

Production.

Copper Production and Prospects. Gives statistics, conditions, and commercial history of copper in 1906. 4000 w. Eng & Min Jour—Jan. 5, 1907. No. 81471.

Pyritic Smelting.

Notes and Comments on the Pyritic Process of Mount Lyell, Tasmania. Reginald Nicholls. A general outline of this process as applied to copper ores, enlarging on important details. 3800 w. Jour Chem, Met & Min Soc of S Africa—Nov., 1906. No. 81626 E.

Smelter.

Smelter Charge Handling in the Southwest. Robert B. Brinsmade. A comparison of the different methods in use at three large modern smelters in Arizona and Mexico. Ills. 4200 w. Mines & Min—Jan., 1907. No. 81400 C.

Testing.

The Testing of Copper by the Consumer. Explains the electrical test for the determination of the purity of copper, describing the method in detail. Ills. 2000 w. Brass Wld—Jan., 1907. No. 81938.

GOLD AND SILVER.

Africa.

Gold Mining in West Africa. W. Fisher Wilkinson. Describes the producing mines in the Gold Coast Colony and Ashanti. 1500 w. Eng & Min Jour—Jan. 26, 1907. No. 81957.

Alaska.

Alaska and Its Possibilities. J. T. Cornforth. Read at meeting of the Am. Min. Cong. Information relating to the early history, the gold production, and other metals, the transportation facilities, etc. 1400 w. Min Rept—Jan. 10, 1907. No. 81609.

Assay Furnace.

A Multiple-Muffle Assay Furnace. H. C. Parmelee. Illustrated description of a

furnace devised by J. I. Brown, stating the advantages claimed. 600 w. Eng & Min Jour—Jan. 12, 1907. No. 81601.

Australia.

Metallurgical Methods in Western Australia. Ralph Stokes. Describes the processes evolved to extract the ores, illustrating plants and apparatus. 2500 w. Min Wld—Jan. 5, 1907. No. 81464.

Cobalt.

Cobalt, Ontario. T. A. Rickard. Map, illustrations, and description of this district and its development. 2000 w. Min & Sci Pr—Jan. 5, 1907. No. 81606.

The Mines at Cobalt. Reginald Meeks. An illustrated description of these mines of Ontario, the workings, equipment, location, production, etc. 2000 w. Eng & Min Jour—Jan. 12, 1907. No. 81604.

The Mines of Cobalt. Reginald Meeks. Information in regard to the Buffalo, Coniagas, La Rose, Colonial Silver, King Edward, Green-Meehan and University mines, the methods of mining, etc. Ills. 2500 w. Eng & Min Jour—Jan. 19, 1907. No. 81697.

The Mines of Cobalt. Reginald Meeks. Describes the Kerr Lake or Jacobs mine, the Right of Way mine, and Trethewey, and the workings. Ills. 2000 w. Eng & Min Jour—Jan. 26, 1907. No. 81959.

Concentration.

Wet Crushing and Concentration in Western Australia. Ralph Stokes. An illustrated description of the processes in use on the Kalgoorlie gold field. 2500 w. Min Wld—Jan. 12, 1907. No. 81610.

Cyaniding.

Handling Sand for Cyanide Vats. Charles Butters and Albert F. Crank. An illustrated explanation of features of the Blaisdell system. 1800 w. Min Wld—Jan. 12, 1907. No. 81612.

A New Cyanide Plant. Mark R. Lamb. Plan, elevation, and description. 1100 w. Min & Sci Pr—Dec. 29, 1906. No. 81415.

Progress in Cyanidation During 1906. Alfred James. A review of improvements; the making of slime and the treatment, tube mills, crushing, roasting and conveying, etc. Ills. 3500 w. Min & Sci Pr—Jan. 5, 1907. No. 81605.

Desilverizing Lead.

Tredinnick's Process for Desilverizing Lead. L. S. Austin. Describes the Pattinson process, and the Luce & Rozan improvement, and Mr. Tredinnick's improvement of the latter process. 1600 w. Min & Sci Pr—Jan. 19, 1907. No. 81920.

Dredging.

Gold Dredging in 1906. J. P. Hutchins. An account of the testing of dredging ground, expansion, methods, dredge design, cost, etc. 3000 w. Eng & Min Jour—Jan. 5, 1907. No. 81475.

Gold-Dredging Practice in Central Otago. Hugh R. Macdonald. Briefly reviews the past history of gold dredging in this field, showing the development of this important branch of alluvial mining, and describing the practice. 8000 w. N Z Mines Rec—Nov. 16, 1906. Serial. 1st part. No. 81692 B.

Electric Gold Dredging. Description, with illustration, of an electric dredge in service in Montana. 900 w. Elec Rev, Lond—Jan. 18, 1907. No. 81982 A.

Extraction.

Graphic Evidence of Metallurgical Progress. A. E. Matthews. Illustrates and describes some of the crude devices and methods used forty years ago for extracting gold and silver from the ores of Colorado mines. 3500 w. Ores & Metals—Jan. 5, 1907. No. 81622.

Nevada.

Round Mountain Camp, Nevada. George A. Packard. The location, geology and mining activities of this gold district are illustrated and described. 1200 w. Eng & Min Jour—Jan. 19, 1907. No. 81699.

Placers.

Placer Mining Methods in the Atlin District. Alfred Carmichael. Illustrated description of the dams and plant for obtaining water, and the methods of mining and blasting before hydraulicking. 3000 w. Mines & Min—Jan., 1907. No. 81396 C.

Precious Metals.

The Precious Metals. Gives figures of the production of gold, silver and platinum, with review of the conditions in the chief producing countries. 2500 w. Eng & Min Jour—Jan. 5, 1907. No. 81470.

Queensland.

Some Goldfields of the Cape York Peninsula. Walter E. Cameron. Information in regard to the Starcke, Alice Rever (Philp), Hamilton, and Coen fields. 6400 w. Queens Gov Min Jour—Dec. 15, 1907. No. 82017 B.

Rand.

Rand Metallurgical Practice and Recent Innovations. Discussion of the paper by G. A. and H. S. Denny. 6800 w. Jour S African Assn of Engrs—Nov., 1906. No. 81517 F.

Utah.

The Re-Opening of the Carbonate Mine, Utah. Francis C. Nicholas. An illustrated review of the history of this silver-lead mine, the re-opening of which is under discussion. 1000 w. Min Wld—Jan. 5, 1907. No. 81465.

IRON AND STEEL.

Blast Furnaces.

Blast Furnace Practice at Blaenavon. George Forster Martin. Read before the S. Wales Inst. of Engrs. Describes the important features and the method of working. Ills. 2000 w. Ir & Coal Trds Rev—Jan. 18, 1907. No. 82002 A.

We supply copies of these articles. See page 999.

The Blast Furnaces at the Minnequa Steel Works. Lawrence Lewis. A description of the five stacks of the Colorado Fuel and Iron Company, at Pueblo, with details of construction, the equipment and methods of operation. Ills. 2500 w. Eng & Min Jour—Jan. 26, 1907. No. 81956.

Carbon.

Carbon Estimation. James A. Aupperle. Describes a method for the estimation of carbon in iron and steel by oxidizing the borings, with the use of a single Bunsen burner. 2000 w. Ir Age—Jan. 24, 1907. No. 81766.

Colorado.

The Resources and Strategic Position of the Colorado Fuel and Iron Company. Lawrence Lewis. An account of the development of this industry in the Rocky Mountain region, its water supply, coal and iron mines, production and earnings, with illustrations of the works. 3000 w. Eng & Min Jour—Jan. 12, 1907. No. 81602.

Copper in Iron.

Copper in Iron (Kupfer im Eisen). H. Wedding. Article illustrated with micro photographs showing the effect on the structure of cast iron by alloying it with copper. 900 w. Stahl und Eisen—Dec. 1, 1906. No. 81802 D.

Determination.

Determination of Iron in Iron Ore by the Reinhardt Method (Zur Bestimmung des Eisens in Eisenerzen Nach der Reinhardtschen Methode). Alexander Müller. Critical comparison of various methods with that of Reinhardt. 4600 w. Stahl und Eisen—Dec. 15, 1906. No. 81803 D.

Electric Smelting.

See Electric Engineering, Electro-Chemistry.

Furnace.

Chattanooga Furnace of the Southern Steel Co. Illustrated description of a modern blast-furnace plant. 1300 w. Ir Trd Rev—Jan. 3, 1907. No. 81402.

Heroult Process.

The Heroult Electric Steel Process in Practice. Extracts from a paper by Prof. Eichhoff relating to the Heroult furnace and process, dealing with the conditions, cost, quality, etc. Ills. 2500 w. Ir Age—Jan. 31, 1907. No. 82015.

Nitrogen in Iron.

Nitrogen in Iron (Ueber die Bedeutung des Stickstoffes im Eisen). Hjalmar Braune. Paper read before the "Jernkontoret," Sweden, showing results of chemical and physical researches into the effects of nitrogen on iron. Serial. 3 parts. 7300 w. Ills. Stahl und Eisen—Nov. 15, Dec. 1 and 15, 1906. No. 81801 each D.

Oil Burner.

The Kirkwood Fuel Oil Burner. Illustrates and describes an equipment for open hearth steel furnaces. 800 w. Ir Age—Jan. 17, 1907. No. 81663.

Pueblo, Colo.

The Raw Materials for Steel Making at Pueblo. An illustrated article describing the sources of supply of ore, limestone, and coke; the methods of handling, yards, storage bins, and conveying machinery. 2000 w. Eng & Min Jour—Jan. 19, 1907. No. 81696.

Pyrometer.

See Mechanical Engineering, Measurement.

Regenerative Furnace.

Fiftieth Anniversary of the Regenerative Furnace (Zum fünfzigjährigen Jubiläum des Regenerativofens). L. Beck. Historical account of the development of the Siemens Martin process. 4500 w. Stahl und Eisen—Dec. 1, 1906. No. 81800 D.

Slags.

Tests of Titaniferous Slags. Charles N. Cox, Jr., and Loring C. Lennox. Outlines methods used in making a number of tests on titaniferous slag mixtures, explaining the materials used in making up the slag. 3500 w. Elec-Chem & Met Ind—Dec., 1906. No. 81688 C.

Steel Plant.

The Lackawanna Steel Company. Noteworthy features of the more recent construction work at South Buffalo, N. Y., are illustrated and described. 5500 w. Ir Age—Jan. 3, 1907. No. 81362.

Trade.

See Industrial Economy.

Tungsten.

Tungsten in Natural Steel (Ueber die Wolframbestimmung im Wolframstahl). G. von Knorre. Discussion of various methods for the determination of tungsten in steel. 3000 w. Stahl und Eisen—Dec. 15, 1906. No. 81804 D.

MINING.

British Columbia.

Mining in Ainsworth Camp, West Kootenay. From Report of British Columbia Zinc Commission. Describes the property of the Highlander Mill and Mining Co. The ores are said to average 67 per cent lead, 4 per cent zinc, and 22 ounces silver. 2000 w. Min Rept—Jan. 17, 1907. No. 81712.

The Le Roi Mine—Its Past History and Present Condition. E. Jacobs. An illustrated account of this mine, recently placed on a profit-earning basis. 8300 w. B C Min Rec—Nov., 1906. No. 81437 B.

California.

The Mineral Industry of California During 1906. Lewis E. Aubury. Reviews the development in gold mining, copper, quicksilver, borax, soda, and other minerals. 2700 w. Min & Sci Pr—Jan. 5, 1907. No. 81607.

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China.

Primitive Methods of Chinese Mining. Illustrates and describes methods practiced in the Northern Territory of South Australia, where most operations are carried on by Chinese without European supervision. 2300 w. Min Jour—Dec. 29, 1906. No. 81532 A.

Colorado.

The Idaho Springs Mining District of Colorado J. E. Spurr and George H. Garrey. An authoritative report of this district and the values in gold, silver, lead, zinc and copper. 1000 w. Min Rept —Jan. 17, 1907. No. 81711.

Deep Mining.

Some Problems Connected with Deep Mining in the Lake Superior Copper District. F. W. McNair. An interesting account of some of the difficulties encountered in the deep mining of low-grade ores, and the methods of overcoming them. 3800 w. Sci Am Sup—Jan. 26, 1907. No. 81931.

Some Problems Connected with Deep Mining in the Lake Superior Copper District. F. W. McNair. Address before the Engng. Sec. of the Am. Soc. for the Adv. of Science. Describes the conditions, the vertical and inclined shafts, and the difficulties encountered. 3500 w. Eng Rec—Jan. 12, 1907. No. 81577.

Deep Mining on the Gogebic Range. Discusses the real value and extent of the iron deposits being disclosed in this Lake Superior region, and describes features of the different properties. Ills. 3000 w. Ir Trd Rev—Jan. 17, 1907. No. 81681.

Deposits.

Fissures and Their Filling, Veins and Shoots. Etienne A. Ritter. Explains conditions that give rise to the segregation of metalliferous ores in deposits that may be mined at a profit. 1000 w. Ores & Metals—Jan. 5, 1907. No. 81623.

Dikes.

Dikes. James F. Kemp. Illustrated description of dikes, giving much information concerning them. 3500 w. Min & Sci Pr—Jan. 19, 1907. No. 81919.

Disaster.

A Lesson from the Courrières Explosion. Robert H. Dundas. The appalling loss of life in this French colliery disaster, leads the writer to advocate the abolishment of all naked lights, even in the non-fiery mines, and suggests improved methods of working. 2800 w. Ir & Coal Trds Rev—Jan. 11, 1907. No. 81756 A.

Examination.

Examination of Mines. R. Gilman Brown. Read before the Am. Min. Cong. Compares the methods of the present with those of twenty-five years ago, discussing the fundamental points which lessen the hazards of purchase. 3500 w. Can Min Rev—Jan., 1907. No. 81762 B.

Foreign Countries.

Review of Mining in Foreign Countries in 1906. Reports from the Transvaal, Rhodesia, Mexico, Ontario, and Eastern States of Australia. 12500 w. Eng & Min Jour—Jan. 5, 1907. No. 81477.

Germany.

Electrical Plant of the Dahlbusch Mine. Alfred Gradenwitz. Illustrates and describes the equipment, arrangement and method of operation at a German colliery. 1000 w. Eng & Min Jour—Jan. 12, 1907. No. 81603.

Law.

Weak Points in the Federal Law in Relation to Mineral Lands. George W. Ritter. Discusses the law of the apex and extralateral rights, offering suggestions for preventing abuses. 1000 w. Eng & Min Jour—Jan. 26, 1907. No. 81958.

Manganese.

Manganese Mining in India. L. Leigh Fermor. A report of this industry, and the methods of mining, giving a comparison with foreign production. 1400 w. Min Wld—Jan. 12, 1907. No. 81611.

Minor Metals.

Production of Other Metals and Minerals. Reports the production during 1906 of antimony, tin, quicksilver, and other minerals. 4000 w. Eng & Min Jour—Jan. 5, 1907. No. 81473.

Power Plant.

The Hydraulic Compressed Air Power Plant at the Victoria Mine. D. E. Woodbridge. Illustrated description of this plant in Michigan, its construction, operation, control, regulation and efficiency. 1600 w. Eng & Min Jour—Jan. 19, 1907. No. 81695.

Prospecting.

Prospecting with Churn Drills. F. S. Pheby. Describes the use of these drills in testing a district for copper. 1200 w. Min & Sci Pr—Dec. 29, 1907. No. 81416.

Rope-Way.

See Mechanical Engineering, Power and Transmission.

Sands.

The Mineralogical Examination of Sands. Charles H. Warren. Describes the method of investigation of a large number of samples of river and sea sands, or concentrates from such sands, in connection with work of the United States Geological Survey. 7500 w. Tech Qr—Dec., 1906. No. 81773 E.

Shafts.

Shaft Equipment. H. L. Templer. Abstract of a paper read before the Mech. Engrs' Assn. of S. Africa. Considers some of the disadvantages of the usual systems, using wheeled skips, and submits an improved system. 1500 w. Col Guard —Jan. 4, 1907. No. 81646 A.

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Shaft Sinking in Butte, Montana. B. H. Dunshee. Describes the size, timbering, blasting, plumbing, method of sinking through quicksand, etc. 3000 w. Mines & Min—Jan., 1907. No. 81399 C.

Skip.

A Single Balanced Skip for Lowering in Inclined Workings. S. A. Worcester. Illustrated description of a new installation at the Liberty Bell mine, Telluride, Colo., explaining its advantages and economy. 2000 w. Eng & Min Jour—Jan. 26, 1907. No. 81955.

United States.

Review of Mining in the United States. Reviews the generally prosperous conditions, giving reports by States. 20000 w. Eng & Min Jour—Jan. 5, 1907. No. 81476.

Utah.

The Mining and Mineral Resources of Utah. John Dern. Information concerning the location and output of different regions, and the large deposits of gold, silver, copper, lead, coal, iron, and valuable minerals of various kinds. 4000 w. Mines & Min—Jan., 1907. No. 81398 C.

MISCELLANY.

Antimony.

The Volumetric Estimation of Antimony. James Darroch. Describes a method said to give excellent results with all ores and alloys containing antimony, which is much more accurate than the gravimetric methods, and almost as speedy as the dry assay. 1200 w. Min & Sci Pr—Jan. 19, 1907. No. 81921.

Diamonds.

De Beers Consolidated Diamond Mines. Notes from a paper by Alpheus F. Williams describing the present position, equipment, and practice. 4500 w. Min Jour—Jan. 12, 1907. No. 81742 A.

The Occurrence of Diamonds in Matrix at Oakley Creek, Near Inverell, New South Wales. T. W. Edgeworth David. A brief account of the discovery of four diamonds in the original rock matrix. 1000 w. Min & Sci Pr—Jan. 12, 1907. No. 81694.

Gas Well.

Extinguishing the Flame of a 600-Pound Pressure, Million-Feet Hourly Capacity, Natural Gas Well. W. M. Welch. An interesting account of this well, the manner of its taking fire, and the task of putting it out. Ills. 5000 w. Pro Age—Jan. 1, 1907. No. 81350.

Hot Waters.

Magmatic Waters. Hiram W. Hixon. Discusses the origin and effects of the waters discharged by hot springs, geysers, and volcanoes. 3500 w. Min Jour—Jan. 5, 1907. No. 81645 A.

Lead and Zinc.

Lead and Spelter Production. A review of developments in the lead and zinc industries in 1906, with statistics of production. 8000 w. Eng & Min Jour—Jan. 5, 1907. No. 81472.

Missouri's Great Zinc and Lead Mines. S. F. B. Morse. Reviews the development of this district, the deposits, mining, the uses made of these metals, etc. 3000 w. Mfrs Rec—Jan. 3, 1907. No. 81408.

Mercury.

The Mercury Mines of Monte Amiata, Italy. Gives details regarding these mines. 1700 w. Min Jour—Dec. 29, 1906. No. 81533 A.

Metallurgy.

Metallurgical Progress in 1906. A summary of the new practice and improvements in gold, silver, lead, copper, and zinc. 6000 w. Eng & Min Jour—Jan. 5, 1907. No. 81474.

Mine Gas.

Carbon Monoxide in Mines. J. T. Beard. Considers its properties and source, the dangers attending it, the percentage that will cause death, tests for determining its pressure, etc. 2200 w. Mines & Min—Jan., 1907. No. 81401 C.

Nickel.

The Manufacture of Malleable Nickel. Erwin S. Sperry. An interesting illustrated article giving much information in regard to nickel metallurgy and the production of malleable nickel. 3800 w. Brass Wld—Jan., 1907. No. 81936.

Petroleum.

Petrolum in Southwestern Fields. Holland S. Reavis. The production and present conditions in Texas and Louisiana are discussed. 4800 w. Mfrs Rec—Jan. 3, 1907. No. 81410.

Production of Petroleum. Reports of development and production in California, Texas, Louisiana, Ohio, Indiana, the mid-continent, and Appalachian fields. 5000 w. Eng & Min Jour—Jan. 5, 1907. No. 81478.

Platinum.

Among the Platinum Deposits of the Ural Range. L Lodian. Reminiscences of travels in the platinum region. 3000 w. Elec Rev, N Y—Jan. 5, 1907. No. 81442.

The Occurrence of Platinum. From the Bul. of the Imp. Inst. Describes platinum minerals, the mode of occurrence, and gives the localities where platinum has been obtained. 2000 w. Can Min Rev—Jan., 1907. No. 81763 B.

Potash.

The Potash Industry. George Ryce. Abstract of a paper read before the Engng. & Sci. Assn. of Ireland. Remarks on the importance of this industry in Germany, describing the deposits and methods of mining. 3000 w. Min Jour—Jan. 19, 1907. No. 81987 A.

Progress.

World's Mining Progress Since Early

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Times. Charles C. Schnatterbeck. An interesting lengthy review of progress since the discovery of America, and the features of development most important. The various countries are considered separately, their production, methods, minerals and metals, etc. Ills. 30000 w. Min Wld—Jan. 26, 1907. No. 82009.

Smelting.

Cost of Smelting. W. R. Ingalls. Report of the British Columbia Zinc Commission. Outlines the fundamental principles which determine the total cost of smelting, and gives estimates of cost of smelting in Europe and America. 2200 w. Min Rept—Jan. 17, 1907. No. 81710.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Collision.

Government Investigation of Terra Cotta Collision. Abstract of testimony taken by the Interstate Commerce Commission while investigating this collision in the District of Columbia. 4000 w. R R Gaz—Jan. 11, 1907. No. 81564.

Electric Service.

Opening of Electric Service on the New York Central and the New Haven Railroads. An illustrated article describing the gradual installation of the electric service, and outlining the leading features of the work. 1600 w. Sci Am—Jan. 19, 1907. No. 81690.

Train Service.

Express Train Services of 1906—British and French. Charles Rous-Marten. A review of the service during the year, from the view-point of an engineer. 1200 w. Engr, Lond—Jan. 11, 1907. No. 81754 A.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Air Brakes on Electric Locomotives. Illustrates and describes the method of piping an electric locomotive. 600 w. Ry & Loc Engng—Jan., 1906. No. 81446 C.

Holding Power of Straight Air. Concerning the capacity of the straight air brake. 800 w. Ry & Loc Engng—Jan., 1907. No. 81445 C.

The Chapsal-Saillot Compressed Air Brake. States the advantages claimed by this brake, which is illustrated and described. 1500 w. Engng—Dec. 28, 1906. No. 81535 A.

Brake.

Comparison of Brake Systems. (Kritik der Bremssysteme bei elektrisch betriebene Hebezengen). F. Jordan. The Hebezeng electric brake compared with others. Illus. Serial. 3 parts. 22000 w. Zeitschrift Des Vereines Deutscher Ingenieure—Dec. 15, 22 and 29, 1906. No. 81838 each D.

Buffers.

Buffers During Shunting Operations and During the Braking of Long Trains. J. Doyen. Considers methods of calculating what amount of work a buffer must be able to take up in order to satisfy the requirements of actual practice. 1900 w. Bul Int Ry Cong—Dec., 1906. No. 81383 E.

Car Axles.

See Mechanical Engineering, Machine Works and Foundries.

Cars.

Private Car for the Canadian Pacific. Illustrated description of a handsome private car, the "Killarney," for the use of the president of the road. 900 w. R R Gaz—Jan. 18, 1907. No. 81683.

Steel Coach for the Southern Pacific. Plans and description. 600 w. Ry Age—Jan. 11, 1907. No. 81613.

Steel Passenger Car. Illustrates and describes a sample standard 60 ft. steel coach for the Harriman lines. 500 w. Am Engr & R R Jour—Jan., 1907. No. 81355 C.

Corrugated Flues.

Deformation of Corrugated Flues under External Pressure. (Ueber die Abweichung von der kreisrunden Form der Flammrohre mit äusserem Druck). O. Knaudt. Describes failures of corrugated flues in locomotive and marine service. Illus. Serial. 2 parts. 3100 w. Glasers' Annalen—Nov. 15 and Dec. 1, 1906. No. 81812 each D.

Electric Locomotives.

The Coming of Electric Locomotives. Albert H. Armstrong. Briefly considers the recent electrification of sections of steam-operated lines, and the ends aimed at in the adoption of electric locomotives. 2200 w. Jour Worcester Poly Inst—Jan., 1907. No. 81779 C.

Electric Towing Locomotive for the Teltów Canal (Ergebnisse eines Betriebsversuches an einer elektrischen Schlepplokomotive beim Teltowkanal). Erich Block. Electric "mule" used on the Teltow canal near Berlin, and running on rails laid on the tow-path. Illus. 1100 w. Glaser's Annalen—Dec. 1, 1906. No. 81813 D.

Electric Traction.

Electric Traction for Modern High Tension Vehicles. (Abstract). Carl Wegman. Discusses the systems being worked out for the handling of traffic on standard railways, especially the electric locomotives and the necessary details.

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2500 w. Can Elec News—Jan., 1907 No. 81917.

See also Street Railways.

Lehigh Valley.

Motive Power of the Lehigh Valley Railroad. From "Development of the Locomotive," by Angus Sinclair. Interesting review of the early history of the road, especially the engines used. Ills. 3000 w. Ry & Loc Engng—Jan., 1907. No. 81448 C.

Locomotives.

Balanced Compound Pacific Type Locomotive, National Ry. of Mexico. Illustrations showing the principal features of the design, with dimensions. 500 w. Ry & Engng Rev—Jan. 19, 1907. No. 81709.

Heavy Consolidation Freight Locomotive with Walschaert Valve Gear. Illustrated description of new locomotives for the Delaware & Hudson Co. 500 w. Am Engr & R R Jour—Jan., 1907. No. 81358 C.

Heavy Mogul Freight Locomotive with Walschaert Valve Gear. Illustrated description of very heavy engines, three of which have been built for the Vandalia railroad. 900 w. Am Engr & R R Jour —Jan., 1907. No. 81359 C.

Locomotives for the Italian Government Railways. Illustrates and describes engines recently built in America for these railways. 600 w. R R Gaz—Jan. 11, 1907. No. 81566.

The Heisler Geared Locomotive. Explains the advantage of geared locomotives on grades for which they are adapted, and gives an illustrated description of a recent engine of this type weighing 52 tons. 500 w. Ry Age—Jan. 25, 1907. No. 82006.

4-4-2 type Passenger Locomotive, Hungarian State Railways (Neueste Schnellzugs-Lokomotivtype Kategorie .I der Königl ungarischen Staatsbahen). R. Nagel. Illustrated description of Atlantic type engine to pull 300 ton trains at 86 miles per hour. 2200 w. Glaser's Annalen—Dec. 15, 1906. No. 81816 D.

New Lococotives, Buenos Ayres and Rosario Railway. Illustrates and describes three types of engines being put to service on this line, which is the most important in South America. 800 w. Prac Engr—Jan. 18. 1907. No. 81977 A.

Passenger and Freight Locomotives. Illustrates and describes a Pacific type passenger engine, and a consolidation type freight engine, built for the Central of Georgia railway. 500 w. Am Engr & R R Jour—Jan., 1907. No. 81360 C.

2-8-2 Type Electric Locomotive. Illustrated description of the electric locomotives for the New York Central lines, with report of results obtained. 2200 w. Am Engr & R R Jour—Jan., 1907. No. 81354 C.

Ten-Wheel Coupled Locomotive with Schmidt Superheater. Illustrated description of an engine exhibited at Milan. Plate. 700 w. Engng—Jan. 4, 1907. No. 81650 A.

Six-Coupled Bogie Passenger Engine—Caledonian Railway. Illustrated description of an engine of the 4-6-0 type, with inside cylinders driving on the front axle of the coupled wheels. 300 w. Engr, Lond—Dec. 28, 1906. No. 81543 A.

Mogul Locomotives for the Vandalia. Illustrates and describes heavy (2-6-0) locomotives recently built. 1000 w. R R Gaz—Jan. 4, 1907. No. 81439.

Mexican Central Oil Burner. Illustrated description of 2-8-0 freighters burning crude oil. 600 w. Ry & Loc Engng—Jan., 1907. No. 81449 C.

Locomotive Tests. Dr. W. F. M. Goss. Compilation from a publication by the Pennsylvania Railroad entitled: "Locomotive Tests and Exhibits. The Pennsylvania Railroad System at the Louisiana Purchase Exposition." Ills. 10300 w. Bul Int Ry Cong—Dec., 1906. No. 81384 E.

Locomotive Work on the Northern Railway of France. A report of performances during August, 1906, showing every day work under ordinary conditions. 3500 w. Engng—Jan. 4, 1907. No. 81651A.

National Characteristics in Locomotive Building. Abstract translation of a summary given by Maurice Demoulin. 3000 w. R R Gaz—Jan. 25, 1907. Serial. 1st part. No. 81925.

The Modern Locomotive—1906. Carl B. Smith. A brief review of the development, especially recent progress. 4000 w. Jour Worcester Poly Inst—Jan., 1907. No. 81780 C.

The Steam Locomotive of the Future. Lawford H. Fry. Gives an illustrated study of present types, considering the combustion of the fuel, production of the steam, utilization of the steam, and impulsion by the adhesion of the driving wheels. 5000 w. Cassier's Mag—Jan., 1907. No. 81784 B.

Oil Fuel.

The Use of Oil Fuel for Locomotives. Abstract of a committee report to the Trav. Engrs'. Assn. Reviews the history of the use of this fuel in the United States. Ills. 2000 w. Eng News—Jan. 10, 1907. No. 81558.

Overbalancing.

The Overbalancing of the Locomotive. (Das Wogen und Nicken des Lokomotive). W. Lindemann. Mathematical treatment of the subject. Diagrams. 1600 w. Glaser's Annalen—Jan. 1, 1907. No. 81823 D.

Repairs.

Repairs to Steel Freight Cars. J. F.

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Mac Enulty. Extracts from a paper read before the New England R. R. Club. Suggestions for making these repairs at small cost. Ills. 1800 w. Am Engr & R R Jour—Jan., 1907. No. 81357 C.

NEW PROJECTS.

Improvements.

Railway Improvements on Tynesides. Describes and illustrates the work involved in the construction of a new double-line railway, and the difficult task of diverting the main line of the North-Eastern Railway. Ills. 2400 w. Engr, Lond—Jan. 11, 1907. No. 81750 A.

New Mexico.

The Eastern Railway of New Mexico. Illustrated description of a line to be added to the Santa Fé system, its route, construction, etc. 2000 w. Ry Age—Jan. 18, 1907. No. 81706.

PERMANENT WAY AND BUILDINGS.

Cross-Ties.

Cross-Tie Conditions in Some Foreign Countries. Information from various countries, sent in response to a letter sent out. 4000 w. R R Gaz—Jan. 11, 1907. No. 81565.

The Present Outlook for Railway Tie Preserving Processes in the United States. Samuel M. Rowe. Reviews what has been accomplished with zinc chloride and creosote, and outlines some new processes being tried. 2500 w. Eng News—Jan. 17, 1907. No. 81670.

Grades.

Uniformity of Requirement and Clearness of Specification in Agreements for the Graduation of Railroads. W. F. Dennis. Considers some of the matters covered in contracts for graduation. 12400 w. Pro Am Soc of Civ Engrs—Jan., 1907. No. 81912 E.

Power Plant.

See Mechanical Engineering, Power and Transmission.

Reinforced Concrete.

Reinforced Concrete for Railway Purposes (Die Anwendung des Eisenbetonbaues für Eisenbahnzwecke). Herr Labes. Address to the German Railway Society, Berlin. 3500 w. Glaser's Annalen—Dec. 1, 1906. No. 81815 D.

River Encroachments.

Struggle of the Chicago & Alton Against the Encroachments of the Missouri River. An illustrated account of the changes due to the vagaries of the river, and the works constructed at different points for the protection of the banks. 2000 w. Ry Age—Jan. 25, 1907. No. 82005.

Roadbed.

The Roadbed of the Future. J. W. Schaub. Presents the advantages of concrete in securing both economy and comfort. Ills. 1700 w. Cement Age—Jan., 1907. No. 81797.

Shops.

East Decatur Shops of the Wabash. Illustrated description of new car repair shops in Illinois. 2000 w. Ry Age—Jan. 4, 1907. No. 81443.

The El Paso & Southwestern R. R. Shops. J. L. Campbell. Illustrates and describes new shops in which reinforced concrete is largely used. 2500 w. Eng Rec—Jan. 5, 1907. No. 81489.

Signaling.

Railway Signaling. T. George Wilson. Gives a general outline of what is accomplished by interlocking, the manner in which the work is done, and the construction of a particular type of machine. Ills. 3000 w. Elec Jour—Jan., 1907. Serial. 1st part. No. 81786.

Methods of Remedying the Interference of Foreign Current with Automatic Block Signals. Some of the methods of overcoming the effects proposed by a committee of the Railway Signal Assn. 2500 w. Eng News—Jan. 10, 1907. No. 81555.

The Track Circuit as Installed on Steam Railways. H. G. Brown. Read before the Inst. of Elec. Engrs. A description of the track circuit only, as installed on steam railways, of the method of its operation, and of the laws governing its working. 3500 w. Elec Engr, Lond—Jan. 4, 1907. No. 81636 A.

Stations.

New Union Station at Seattle. Illustrated description of a recently completed and very beautiful station. 700 w. Ry & Engng Rev—Jan. 19, 1907. No. 81708.

The New Union Station at Lexington, Kentucky. Illustration and plan, with description. 800 w. R R Gaz—Jan. 18, 1907. No. 81686.

Washington's Great Union Station. Frank N. Bauskett. Illustrated description of the beautiful station nearing completion, calling attention to points of special interest in the construction. 1000 w. Sci Am Sup—Jan. 19, 1907. No. 81691.

Tool Room.

Tool Room Care and Economy. F. G. de Saussure. Suggestions in regard to a checking system for tools, and other helpful methods of securing economy. Ills. 1800 w. Am Engr & R R Jour—Jan., 1907. No. 81356 C.

TRAFFIC.

Car Shortage.

A Plan to Relieve Car Shortage and Congestion. Letter from Russell Harding, giving what he considers the chief causes of car shortage and congestion, and explaining a method of testing the truth of his assertions. 1600 w. R R Gaz—Jan. 18, 1897. No. 81684.

Car Shortage in the Middle West. Some of the causes of car shortage and the trouble it causes in the coal business.

We supply copies of these articles. See page 999.

1100 w. Min & Sci Pr—Jan. 12, 1907. No. 81693.

Some Lessons of the Car Famine. Editorial discussion of the present situation in transportation of supplies, with notes from the report of Hon. Franklin K. Lane, summing up the facts, and considering the causes. 2200 w. Eng News—Jan. 17, 1907. No. 81672.

Rates.

Argument Against Uniform 2-Cent Mileage. Extracts from the argument made by J. M. Johnson, in behalf of the Denver & Rio Grande, in opposition to the Sherman bill providing for the issuance of mileage tickets at 2-cents per mile. 1800 w. Ry Age—Jan. 18, 1907. No. 81707.

MISCELLANY.

Belts.

See Mechanical Engineering, Power and Transmission.

Law.

The Interstate Commerce Act as amended. Frank Haigh Dixon. Abstract from the *Qr. Jour. of Economics.* A review of the new law and the increased authority given the Commission. 2500 w. R R Gaz—Jan. 18, 1907. No. 81682.

New Jersey.

The United Railways of New Jersey. C. H. Caruthers. Reviews the early history of railroad construction and operation in New Jersey, giving illustrated descriptions of the locomotive equipment used, and other matters of interest. 4500 w. R R Gaz—Jan. 11, 1907. No. 81563.

Refrigeration.

Railroad Refrigation. Jos. H. Hart. Remarks on the inadequate methods in present use, and the application of mechanical refrigation. 2000. R R Gaz—Jan. 18, 1907. No. 81685.

State-Owned Railroad.

The First Government Railroad in America. An editorial letter, from P. F. Kupka, giving the history of the first state-owned railroad, in Pennsylvania, and its methods. 3500 w. R R Gaz—Jan. 11, 1907. No. 81562.

STREET AND ELECTRIC RAILWAYS

Birmingham, Eng.

Birmingham Corporation Tramways. Reviews the history and gives an illustrated description of the overhead electric system of municipal tramways. Map. 7500 w. Tram & Ry Wld—Jan. 10, 1907. No. 81770 B.

Cable Truck.

Cable Transport Truck for Street Service. (Kabeltransportwagen für Strassennerkehr). R. Floegel. Convenient design of three wheeled truck, used in Breslau. Illus. 900 w. Glaser's Annalen—Jan. 1, 1907. No. 81818 D.

Car Barns.

New Car Barns of the Brooklyn Rapid Transit Company. Illustrated description of barns costing nearly $800,000. 700 w. Elec Ry Rev—Jan. 12, 1907. No. 81615.

Cars.

A Model Car for Long Travel. W. H. Evans. Read before the Cent. Elec. Ry. Assn., Indianapolis, Ind. Presents points where improvements are needed to meet the requirements of long distance interurban service. 2000 w. Elec Ry Rev—Jan. 26, 1907. No. 81967.

Car Equipment of the Vienna-Baden Single Phase A. C. Road. (Der Wagenpark für die Einphasen-Wechselstrom-Bahn Wien-Baden). Illus. 2700 w. Elektrotechnische Zeitscrift—Dec. 13, 1906. No. 81834 B.

The New Car Equipment for the Boston Elevated Railway Company. Illustrates and describes cars embodying the latest developments in the construction of steel passenger coaches. 700 w. St Ry Jour—Jan. 12, 1907. No. 81589.

Catenary.

Catenary Line Construction. C. E. Eveleth. Explains the advantages claimed for this construction. 2000 w. St Ry Jour—Jan. 19, 1907. No. 81705.

Chicago.

The Union Loop of Chicago and a Proposed Terminal Station System for the Elevated Railways of Chicago. J. B. Strauss. Explains the present conditions and traffic congestion and the proposed remedies. 3500 w. Eng News—Jan. 31, 1907. No. 82022.

Electrification.

Some Remarks Regarding Railway Electrification. Philip Dawson. Discusses the electrification of the London Metropolitan District Railways, showing that other causes than the method of haulage have seriously interfered with the success of these lines. Also considers factors of importance on such systems. 2000 w Elec Rev, Lond—Jan. 18, 1907. No. 81981 A.

Feeders.

The Use of Steel Rails for Electric Railway Feeders. Julius Alsberg. Report of conductivity tools made of various steel rails, both for third rail and service use, with calculations of comparative costs of copper feeders and steel rails. 1500 w. Eng News—Jan. 10, 1907. No. 81560.

We supply copies of these articles. See page 999.

Lighting.

Car Lighting. R. C. Taylor. Read before the Cent. Elec. Ry. Assn., Indianapolis, Ind. Considers headlight requirements, interior lighting, etc. Ills. 1800 w. Elec Ry Rev—Jan. 26, 1907. No. 81966.

London.

The Victoria Embankment Tramway. Outline map and illustrated description of features of this new line. 2500 w. Tram & Ry Wld—Jan 10, 1907. No. 81771 B.

New Jersey.

The Morris County Traction Company's Inter-Suburban System in New Jersey. An illustrated article explaining the purpose of this system of railways, and describing details. 1500 w. St Ry Jour—Jan. 12, 1907. No. 81586.

New Mexico.

The Las Vegas Railway & Power Company. Illustrated description of this railway and power plant. 2000 w. St Ry Jour—Jan. 26, 1907. No. 81962.

Paris.

The Paris Metropolitan Railway. Map showing the network of lines completed and proposed, with an account of the working, rates, etc. 2700 w. Engng—Jan. 11, 1907. No. 81744 A.

Power.

The Cost and Sale of Railway Power. G. H. Kelsay. Read before the Cent. Elec. Ry Assn., Indianapolis, Ind. Considers the factors involved when estimating the cost of power for the purpose of sale. 3000 w. Elec Ry Rev—Jan. 26. 1907. No. 81965.

Rails.

Rail Creeping and Expansion. E. Goolding. Briefly considers the causes of their movements. 1000 w. Elec Engr, Lond—Jan. 11, 1907. No. 81732 A.

Standard Rail Sections for Paved Streets. C. Gordon Reel. Reviews the history of the girder rail, and states the advantages of T-rail sections, giving data from many cities. Ills. 6000 w. St Ry Jour—Jan. 26, 1907. No. 81963.

Rail-Welding.

Thermit Rail-Welding—Experiences of the Utica & Mohawk Valley Railway Company. M. J. French. Gives a brief description of the details of the thermit welding process, and of special features in the work on the road named. Ills. 3000 w. St Ry Jour—Jan. 12, 1907. No. 81587.

Review.

Electric Railroading in 1906. Dr. Louis Bell. A review of the progress during the year, which shows improved construction, and the introduction of electricity on steam roads, especially the terminal division of the N. Y. Central. 2500 w. Elec Rev, N Y—Jan. 12, 1907. No. 81591.

Shops.

Shop Practice at Memphis. Illustrates and describes the shop and car houses at Memphis, Tenn., their equipment and methods. 3000 w. Elec Ry Rev—Jan. 26, 1907. No. 81964.

Standardization.

Standard Car Connections. H. Schlegel. Presents the advantages and gives suggestions adapted from actual experience in standardizing connections on a system employing ten kinds of motor equipments. 1800 w. St Ry Jour—Jan. 12, 1907. No. 81588.

Storekeeping.

Records of the Storekeeping Department, Denver City Tramway Company. An explanation of the methods used, giving blank forms. 1700 w. Elec Ry Rev—Jan. 12, 1907. No. 81616.

Substations.

New Substations of the Metropolitan West Side Elevated Railway Company. Illustrated detailed description of two rotary-converter substations of interesting design, recently put into operation in Chicago. 2000 w. Elec Ry Rev—Jan. 19, 1907. No. 81702.

Portable Electric Railway Substations. Brief illustrated description of electric substation equipment as used on two interurban railroads in the United States. 700 w. Ry & Engng Rev—Jan.. 12, 1907. No. 81614.

Third Rail.

Third Rail Construction. E. Goolding. Calls attention to defects found in third-rail construction and to recent improvements in design. Ills. 1500 w. Elect'n, Lond—Jan. 11, 1907. No. 81738 A.

Tracks.

Concrete Stringers, Concrete Stringers with Ties, and Steel Ties. F. D. Jackson. Read before the N. Y. State St. Ry. Assn. Treats especially of concrete stringers with and without ties, and solid concrete in the track. Ills. 1200 w. Elec Ry Rev—Jan. 19, 1907. No. 81704.

Track Construction in Paved Streets. I. E. Matthews. Read before the N. Y. State St. Ry. Assn. Deals principally with the types of construction used in Rochester, N. Y. 2000 w. Elec Ry Rev—Jan. 19, 1907. No. 81703.

Tramways.

Some Notes on the Maintenance of Pier Tramways. H. Large. Directions for the proper care of equipment and tracks on lines at seaside towns, used only during the summer season. 2000 w. Elec Engr, Lond—Jan. 18, 1907. No. 81979 A.

Vienna.

The Electrical Equipment of the Vienna Metropolitan Railway. Describes the equipment. Ills. 1500 w. Elect'n, Lond—Jan. 4, 1907. No. 81641 A.

We supply copies of these articles. See page 999.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

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Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.

Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Electrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingeniería. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy, United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de F r. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

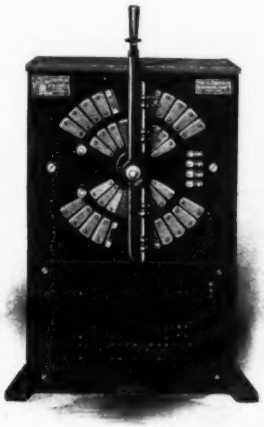
IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

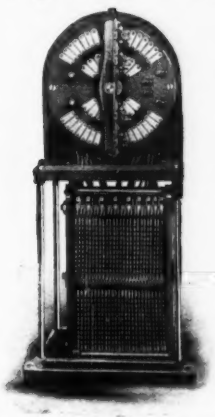
A New Line of Controllers.

THE Electric Controller & Supply Co., of Cleveland, Ohio, are placing upon the market a new line of controllers termed Type G which have a rating of 1 to 50 H. P. These controllers were built to meet the requirements of general crane service where the conditions are not severe enough to demand the use of the Dinkey ventilated controller. The Type G-3 and G-4 controllers are built with coil resistance and the Type G-5 and G-6 controllers are built with cast grid resistance. When it is desired to place controllers above or in the



TYPE G-5 CONTROLLER, FRONT VIEW.

rear of the operator the Type G controller is furnished arranged for under lever operation. They are also furnished with spring return for operation from the floor by means of pendent ropes or chains. A number of crane users have decided that a 15 or 20 ton crane requiring a 25 or 30 horse-power motor on the hoist and bridge motion may be operated from the floor by any of the men in the shop, thus saving the wages of a crane operator who would probably be idle half his time. It is a very simple matter to put cutouts at either end of the trolley travel and at either end of the runway to prevent accident. The Type G controller meets this demand for a controller up to 50 horse-power arranged for operation from the floor by means of ropes. This controller is a self-contained unit, the resistance being placed in the frame, making it necessary to run only four wires between the controller and motor. Reversal is accomplished by the use of a single lever, no separate reverse switch being required. The Type G controllers are self-contained, compact, and accessible. All parts are made to jig and are interchangeable. The contact face is of heavy slate, free from metallic veins. The contact segments are of copper which are screwed to brass lugs to which all wiring connections are made. By this construction any of the contact segments can be removed and replaced without disturbing the wiring connections. The contact



TYPE G-6 CONTROLLER, FRONT VIEW, ALL CASES REMOVED SHOWING RESISTANCE AND FACE OF CONTROLLER.

arms is of soft cast iron and carries the fingers and finger holders, the insulation of

which is of heavy pressed vulcabuston bushings. The contact fingers are of dropped forge copper of great hardness and may be removed and replaced without removing the contact arm. A powerful and effective blow-out is provided in all sizes of these controllers. The frame for Type G-3 and G-5 controllers consists of a main casting in one piece provided with a cover, the removal of which affords easy access to all resistance connections. The case enclosing this frame is of perforated steel, thus allowing ample ventilation. The frame of the G-4 and G-6 controllers consists of a bottom casting which supports the resistance, and a top casting which supports the contact slate and arm. The top and bottom casting are connecting by means of four steel corner posts around which a casing of perforated steel is provided for ventilation and protection to resistance. The top casting of the G-4 and G-6 controllers supports the contact slate which is completely covered and protected by a sheet steel casing. This protects the operator from coming in contact with any live parts of the controller, and also protects the working parts of the controller from dust and dirt. Easy operation is secured by a lever which is keyed to the arm shaft at the back of the top casting, which gives a short movement of about 10 inches in either direction for both starting and reversing. The resistance for the G-5 controller is built of cast grids in a single bank which may easily be removed as a unit without disturbing the other parts or moving the controller. The resistance for the G-6 controller is made of two banks supported on bars attached to the frame, and may be removed in separate units without disturbing the other parts. The resistance for Type G-3 and G-4 controllers is made up of Type E coils which consist of a heavy asbestos tube stiffened by means of a central brass tube which serves to bring the rear terminal forward, facilitating the necessary connections. These controllers are very adaptable for service up to 500 volts. Six points of control are provided with the G-3 and G-5 controllers, and eight points of control with the G-4 and G-6 controllers.

The Cone Gas Generator.

THE Cone gas generator, using bituminous coal, and now manufactured for the United States by the Cone Gas Machine Co., Detroit, occupies a field entirely its own by its revolutionary improvements in the generation of gas. Until this machine was demonstrated it has been considered impossible to use bituminous coal in a gas generator without the formation of tar, requiring the addition of expensive auxiliary machinery to remove or burn it, which made it impractical in most power plants. The Cone vacuum process entirely removes this difficulty, and not only does not form tar, but preserves in a fixed gas the ethylene and methane series (the highest heating gases yielded by the coal) which in all other soft coal producers are destroyed by destructive distillation. The process employed in the Cone generator is an entirely new departure in gas making, and really combines in one the three known methods of securing gas from coal, viz., (1) distillation by which the volatile hydro-carbons are driven off as in illuminating gas; (2) the water gas process in which the elements of water H_2 and O are dissociated in the presence of incandescent carbon, the element O uniting with carbon to form CO and the element H being set free; (3) the air gas process by which the O of the air forced through the incandescent fuel unites with the free carbon to form CO or carbon monoxide, the well known fuel gas,—thus utilizing all the available heat obtainable from the coal, and leaving nothing but ash as a waste.

This seemingly complicated process is, however, simplicity itself in its application and when understood. Its method may be explained as follows: The fuel is divided into two zones called the primary or lower zone and the secondary or upper zone. The coal is introduced at the top and passes through the different processes of distillation, until by the time it reaches the primary zone it is coke. The coke in this zone is exposed to air only, admitted through the rose in the center, and keeps this part of the fuel at incandescent heat continually whether the generator is run-

ning on full load or on no load. The vaporizer located between the primary and secondary zones, supplies large quantities of steam at this point and thereby retards combusion of the coal above, sufficiently to prohibit destructive distillation of the higher volatiles which pass off in a fixed gas. The union of the elements to form tar is prevented as follows: (1) by the excessive amount of steam introduced and (2) by coming in contact with the cooler surface of the air and water heaters shown surrounding the reservoir at the top of the generator. The result of this process briefly stated is: (1) that it is entirely automatic, requiring no attention but to feed the coal and remove the ashes; (2) it gives a perfectly tarless gas of high calorific value; *(3) while the fuel is passing through the different stages of distillation the heat is too low to make clinker, but when the coke reaches the primary zone it is too well digested to form anything but small clinker which passes out freely with the ashes; (4) the machine will always respond instantly from no load to full load, as a high heat is always maintained in the primary zone and increases the output of gas the moment the suction is increased; (5) it yields a gas from cheap bituminous coal or lignite, greatly exceeding in heat value the gas obtained from the more expensive anthracite.

Many well known gas engineers have made exhaustive tests of this machine and are enthusiastic in its praise; space prevents the insertion of these tests, but they can be obtained by addressing Cone Gas Machine Co., Detroit, Mich.

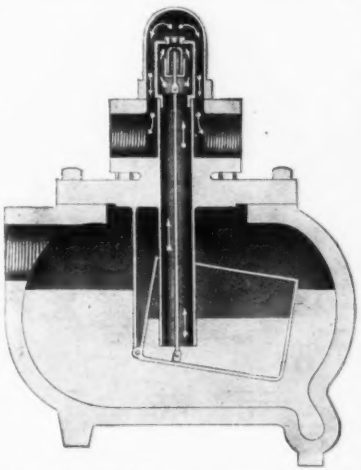
*Gas made in the Cone producer from Pocahontas coal, tested by means of the Junker calorimeter showed it to have a heating value of 233.5 B. T. U. per cubic foot at 0° and 760 m-m barometer pressure. It had the following composition:

CO_2	C_2H_4	O_2	CO	H_2	CH_4	N_2
5.0	2.0	1.0	12.8	18.1	8.4	32.7

Testing a Steam Trap at High Pressure.

THE accompanying photograph shows a new Squires steam trap operating at 375 pounds pressure in a test made by its inventors, C. E. Squires and Benjamin Silliman of Cleveland, Ohio. The trap has just discharged, throwing out 241 cubic inches of water in less than one second. The impression that steam is escaping with the water is erroneous. Steam does escape from some traps, but usually as a result of wire-drawing between the periods of water discharges. The appearance of steam in the photograph is due to the fact that vapor "takes" in a photograph as steam and that part of the water discharged at high temperature and pressure flashes into steam instantly on being liberated. In this instance very little moisture came down, all having been converted into vapor before there was time to reach the ground.

The unusual method of supplying steam used in testing these traps was adopted because there were no high pressure boilers available, the Cleveland Electric Illuminating Company with a maximum of 165 pounds offering the next highest steam pressure in the city. The automobiles are



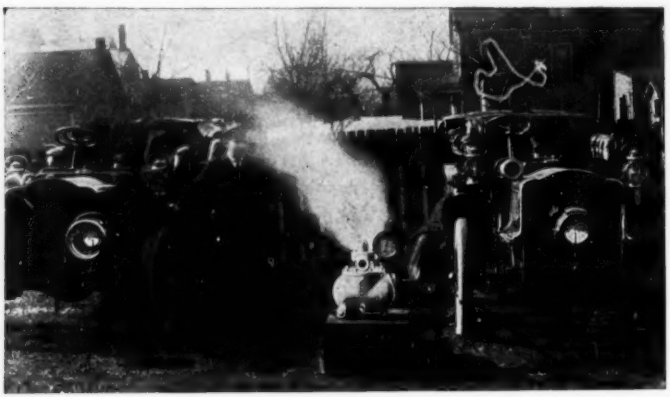
1906 model White steamers equipped with feed water heaters. Their running pressure varies from about 150 to 450 pounds at the steam chest of the engines. The boiler pressures are much higher, the safety valve usually being set between 1,000 and 1,200 pounds. In these tests the safety valves were set for 750 pounds.

After subjecting the trap to 1,000 pounds per square inch hydrostatic pressure at the factory, it was connected to the automobile as shown, so that steam at various pressures entered from the boiler of the machine on the right, and heated water at similar pressures entered from the feed

pump of the one on the left. Water could then be turned into the trap in any quantity, taking the place of condensation in ordinary service.

Steam alone was admitted to the trap at first until the gauge indicated 600 pounds, the pressure which was maintained for some time to test the gaskets. These are vital parts in high pressure work, as they must be unaffected by the moisture of saturated and the heat of superheated steam, and as the joints must come apart easily for inspection of the trap interior. In this test the joints remained perfectly tight. The packing used was a special corrugated copper gasket, which, in addition to meeting the requirements mentioned, does not deteriorate if the joint is taken apart often. A feature of the trap tested adapting it to high pressure work is the placing of the joints entirely above the water line. Traps having the main joint partly in contact with steam and partly with water will do on medium pressures, but, owing to the widely varying temperature of the contained water and steam at high pressure, begin to leak from the effect of unequal expansion. A second test was made to find the highest pressure at which the trap would operate.

The following short description, in connection with the cross-sectional view of the trap will enable the reader to understand the manner in which the trap works. Its action depends upon the buoyancy of a cast iron bucket hinged on cone bearings at one side and connected to the valve mechanism by a similarly hinged brass rod. The proportions of the bucket and the location of the valve rod are such that at atmospheric pressure the bucket when submerged exerts a pull of six pounds on the valve rod. In practice when condensation has reached the high water line the bucket fills, sinks and opens an auxiliary valve which is ⅛ inch in diameter. Pressure under the main valve is thus relieved and it is pushed down and open instantly by the internal trap pressure upon its upper surfaces. The bucketful of water is then discharged, and the bucket on rising closes both valves until the operation is repeated. No wire-drawing is possible, as the valves are always wide open or closed tightly.



To keep the auxiliary valve (⅛ inch in diameter or .01227 sq. inch in area) shut against the pressure of 6 pounds pull on the stem from the bucket the steam must exert a pressure in pounds per square inch of 6 x 1/.01227 or about 490. These figures neglect the variation in density of water at high temperatures and conditions of motion within the trap. To prove these figures, enough water was pumped into the trap to cover the bucket, and by opening the air vent, the pressure was gradually lowered until the trap began to discharge. This did not occur until the gauge showed 375 pounds, a result which emphasizes the importance of service tests on steam apparatus when reliable data are required.

Additional water was continually pumped in and discharged at this pressure for ten minutes. The action of the valve was accompanied by slight vibration. The discharge sounded like the exhaust of a two-ton steam hammer and could be heard some distance. The pressure was further reduced to 300 pounds, and water pumped into the trap in a continuous stream. The valve action was smooth, and the trap proved itself capable of maintaining perfect operation for an indefinite period.

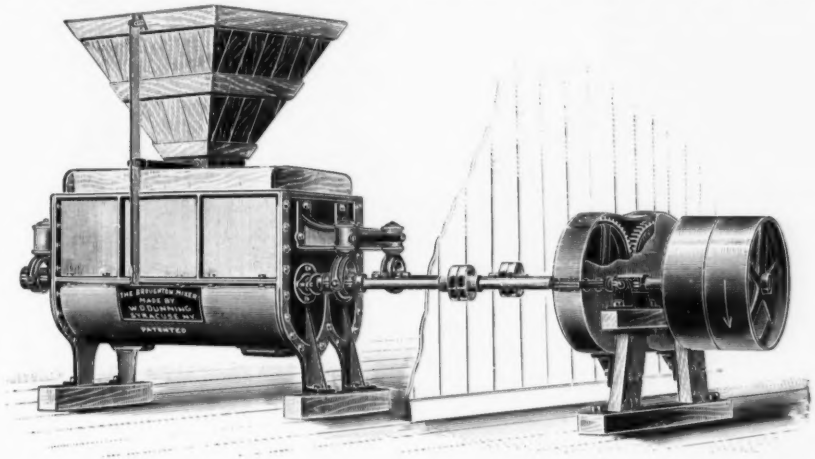
These tests should interest those who use steam at high temperatures and pressures, and high-pressure plants are increasing yearly. The Squires trap is made by Strong, Carlisle & Hammond Co., of Cleveland, Ohio.

The Broughton Mixer.

THE Broughton mixer, as shown by the accompanying cut, has been used successfully for mixing gun powder for a number of years. The same mixing qualities which have made it a favorite with the largest wall plaster manufacturers in the United States and Canada for the past fifteen years assert themselves equally well in mixing gun powder. The essential point in getting a perfect mixture is to have a mixer that will mix together light and heavy materials evenly, as when one material is heavy and the rest light the tendency in most mixtures is for the heavy to work to the bottom and the light to come to the top.

The Broughton mixer has two shafts running side by side through the mixing chamber which is circling at the bottom, and the mixing paddles are secured to the shafts at an angle in such a manner that, as the shafts rotate in opposite directions, the paddles on their upward movement towards the center of the mixing chamber lift the different materials from the bottom of the case. In so doing one set of paddles casts the materials toward one end of the case while the other set casts it in the opposite direction. This reverse action causes the various ingredients, whether light or heavy, to become thoroughly and uniformly mixed.

All parts of this mixer which come in contact with the powder are made of either brass or aluminium, to guard against explosion.



The American Typewriter.

THE American typewriter provides a medium priced business-like machine, of the type-bar style, with all the advantages of the regular type-bar machine, and the added advantage of a saving of about 1,200 small parts in the finished machine. This great saving in parts is accomplished by forging the key and the type on a single bar of steel—the key at one end and the type at the other. The

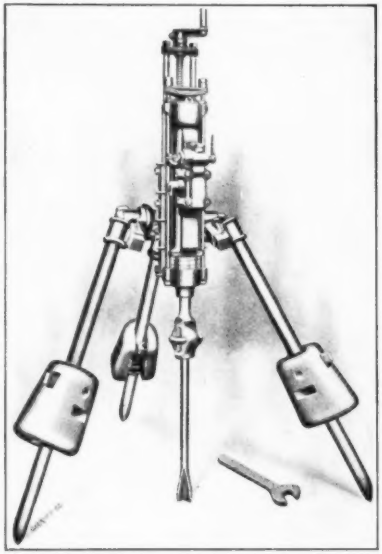
type bar, therefore, is only a simple lever, entirely free from complicated mechanism, and actually cannot get out of order. The weakness of the type bar action of typewriters is in the looseness which soon comes from the wearing of their joints. Some typewriters have as many as sixteen bearings between the key and the type, and some one of these is bound to work loose, spoil alignment and finally break down.

Of equal importance are the ball and socket bearings on which the type bars swing. This simple bearing insures freedom of action and minimum friction, and, consequently, light touch and high speed. The carriage and wheel escapement are mounted on ball bearings—the most approved aids to speed in typewriter construction.

The machine possesses the advantage of the insertion of special characters, such as fractions, accents, special marks, etc., in half a minute's time and changeability of carriage when that may be required. This typewriter possesses a number of other novel and exclusive features described in full in a pamphlet entitled "The American Way." The American Typewriter Co., 268½ Broadway, New York, will send it on request.

The Chicago Giant Rock Drill.

THE designing of a successful machine rock drill is an alluring proposition, calling for an intimate and practical knowledge of the conditions and ruggedness of service in which it has to operate and perform successful work. As it stands to-day, the machine rock drill represents an evolution of features of improvement, made necessary by a long line of demonstrations and failures in actual service. In the design and development of the machine shown in the accompanying illustration, the Chicago Giant Rock Drill, full advantage has been taken of the opportunities presented by embodying such features as have proved their fitness in successful service and combining them with improved features. Every detail has been given careful consideration as to its desirability, suitability of material and weight. Some of the improved features are—the shell which is of the adjustable type, constructed so as to provide for double side bearing for the cylinder; and the shell caps are so made that they will take up wear in two directions, horizontal and vertical, with one adjustment. A removal cylinder stop is also provided in the lower end of the shell. Its function is to prevent the cylinder from slipping out of the shell in case the feed screw should be run out of the feed nut. On the other hand, should it be desired to remove the cylinder from the shell, all that is necessary is to remove the stop first, then by turning the feed screw run the cylinder down in the shell until the feed screw is out of the feed nut; this



will allow the cylinder to be slipped out of the shell without any dismantling of the machine.

The cylinder is cast from a special mixture, having a tensile strength of 35,000 to 38,000 pounds and presenting a fine polished surface when finished. The upper end of the cylinder is extended to form a chamber for the rotating mechanism which is of the releasing type. Three parts are used, thus equally distributing the rotating effect and the pawls are constructed so that they are reversible; *i. e.*, should one of the engaging edges wear out, the pawl can be reversed so as to present the other and un-

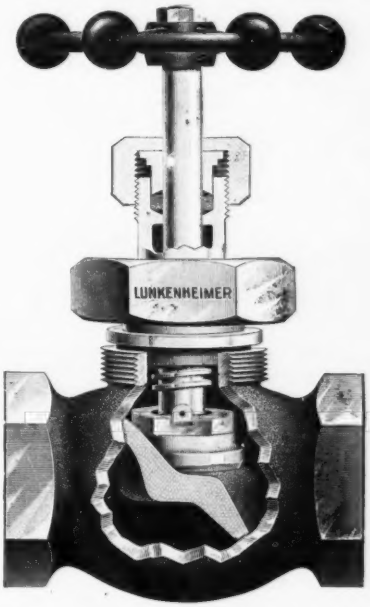
worn edge to engage with the ratchet. This is an important point, as it makes provision for doubling the life of each pawl. The ratchet is of one piece with the rotating or rifle bar, which is extended on its upper end to fit into a chamber or recess into the upper head; this provides for the holding of the rotating bar in a central position and relieves the rotating mechanism of all side strains. The valve motion is positive and is of the tappet or rocker type, modified to give a short stroke feature, the length of the stroke being at all times completely under control of the operator. The supporting pin of the rocker works in renewable steel bushings and is completely enclosed, it being kept in place by caps easily removable but which are securely locked in place by the valve seat when machine is assembled.

One of the most valuable features of the drill is the provision for automatic lubrication. An oil reservoir chamber is provided in the valve seat and communication is made between the oil reservoir and the interior of the valve chest. The oil is led through this channel into the chest where it mixes with the operating fluid and is carried by it into the interior of the machine. One filling of the oil reservoir will last half a "shift." In case the rotating mechanism should not receive sufficient lubrication from the interior, provision is made in the upper head whereby it may be oiled when necessary. Manufactured by the Chicago Pneumatic Tool Co., Chicago, Ill., who will send fuller details on request. The workmanship is of the best and absolute interchangeability of parts is assured.

Improved Regrinding Valves.

THE Lunkenheimer Co., Cincinnati, have made a number of desirable improvements on their regrinding valves. The changes, however, are not at all radical, as the valve has been in use for half a century and has proven itself to be of the correct design, having given general satisfaction wherever used. Its manufacturers, however, increased the weight of the valve, not because the thickness of shell, etc., were too light in their former products, but merely as an additional precaution against rough handling while attaching, etc. The medium pattern valves are guaranteed to stand a working pressure of 200 pounds per square inch and the extra heavy pattern up to 350 pounds per square inch. They have also altered the shape of the valve, which not only makes an elegant appearance but also increases the area through the valve, permitting an unobstructed passage through it, the area being more than equal to that of the connecting pipe.

To insure a perfect and strong joint between the pipe and valve, the pipe threads have been made considerably longer, thereby overcoming the danger of stripping threads which so often happens owing to rough and unskilled workmanship in attaching. All sizes of the valves now have



lock-nuts on the hand wheels, which facilitates the taking apart and assembling of the valve for repairs, etc. Referring to the sectional illustration, it will be noticed that the hub which carries the operating stem is secured to the body by a union connection which, in turn, screws over the shell of the valve body. By means of this construction it is impossible for the hub and the body to become corroded together, as

the thread which holds the union ring to the body is protected at all times from the action of the steam, the joint being made between the flange on the hub and the neck of the body. This connection also acts as a tie or binder in screwing over the body and tends to make the valve rigid and strong. The disc A is held loosely to the stem F by means of the lock-nut J, and therefore will adjust itself to the seat very readily and a tight joint can be relied upon. The stem F is fitted with a very strong, durable and long thread and the hand wheel is of ample diameter to insure the easy operation of the valve.

To regrind the valve, the bonnet ring is unscrewed and the trimmings are removed from the body. A wire or nail is placed through the lock-nut and stem, a little powdered sand or glass and soap or oil is placed on the disc and the trimmings are again placed in the valve and reground. The bonnet has a small rim or projection on the bottom thereof which acts as a guide on the inside of the valve neck while regrinding. The seats in the valve-bodies are very small when the valves are sent out from the factory, which permits of considerable regrinding and is considered an important feature.

The valve can be packed under pressure when open or closed and to pack while the steam is flowing through the valve, open it as wide as possible, when the shoulder at the top of the stem thread will form a seat beneath the stuffing box.

The material used is of the highest grade of bronze composition and the workmanship is in every respect commendable. Before being sent out, every valve is thoroughly tested and inspected, the stuffing boxes are packed and they are ready for immediate use.

The company have, in connection with their plant, a complete physical and chemical laboratory, which enables them to manufacture their products of such composition as are best adapted to withstand the chemical actions, strains, etc., to which the various products are subjected.

Gas Engine Designers.

ILLMER & CO., Fourth National Bank Building, Cincinnati, Ohio, have opened an office as gas engine experts, specializing in gas and oil engine design. By centralizing the design work they are not only enabled to deliver high class design at the least cost because of the saving effected in preliminary work, but at the same time the builder gets the benefit of highly specialized experience and is assured of the very best proportions of parts throughout.

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Lighting.

Car Lighting. R. C. Taylor. Read before the Cent. Elec. Ry. Assn., Indianapolis, Ind. Considers headlight requirements, interior lighting, etc. Ills. 1800 w. Elec Ry Rev—Jan. 26, 1907. No. 81966.

London.

The Victoria Embankment Tramway. Outline map and illustrated description of features of this new line. 2500 w. Tram & Ry Wld—Jan 10, 1907. No. 81771 B.

New Jersey.

The Morris County Traction Company's Inter-Suburban System in New Jersey. An illustrated article explaining the purpose of this system of railways, and describing details. 1500 w. St Ry Jour—Jan. 12, 1907. No. 81586.

New Mexico.

The Las Vegas Railway & Power Company. Illustrated description of this railway and power plant. 2000 w. St Ry Jour—Jan. 26, 1907. No. 81962.

Paris.

The Paris Metropolitan Railway. Map showing the network of lines completed and proposed, with an account of the working, rates, etc. 2700 w. Engng—Jan. 11, 1907. No. 81744 A.

Power.

The Cost and Sale of Railway Power. G. H. Kelsay. Read before the Cent. Elec. Ry Assn., Indianapolis, Ind. Considers the factors involved when estimating the cost of power for the purpose of sale. 3000 w. Elec Ry Rev—Jan. 26. 1907. No. 81965.

Rails.

Rail Creeping and Expansion. E. Goolding. Briefly considers the causes of their movements. 1000 w. Elec Engr, Lond—Jan. 11, 1907. No. 81732 A.

Standard Rail Sections for Paved Streets. C. Gordon Reel. Reviews the history of the girder rail, and states the advantages of T-rail sections, giving data from many cities. Ills. 6000 w. St Ry Jour—Jan. 26, 1907. No. 81963.

Rail-Welding.

Thermit Rail-Welding—Experiences of the Utica & Mohawk Valley Railway Company. M. J. French. Gives a brief description of the details of the thermit welding process, and of special features in the work on the road named. Ills. 3000 w. St Ry Jour—Jan. 12, 1907. No. 81587.

Review.

Electric Railroading in 1906. Dr. Louis Bell. A review of the progress during the year, which shows improved construction, and the introduction of electricity on steam roads, especially the terminal division of the N. Y. Central. 2500 w. Elec Rev, N Y—Jan. 12, 1907. No. 81591.

Shops.

Shop Practice at Memphis. Illustrates and describes the shop and car houses at Memphis, Tenn., their equipment and methods. 3000 w. Elec Ry Rev—Jan. 26, 1907. No. 81964.

Standardization.

Standard Car Connections. H. Schlegel. Presents the advantages and gives suggestions adapted from actual experience in standardizing connections on a system employing ten kinds of motor equipments. 1800 w. St Ry Jour—Jan. 12, 1907. No. 81588.

Storekeeping.

Records of the Storekeeping Department, Denver City Tramway Company. An explanation of the methods used, giving blank forms. 1700 w. Elec Ry Rev—Jan. 12, 1907. No. 81616.

Substations.

New Substations of the Metropolitan West Side Elevated Railway Company. Illustrated detailed description of two rotary-converter substations of interesting design, recently put into operation in Chicago. 2000 w. Elec Ry Rev—Jan. 19, 1907. No. 81702.

Portable Electric Railway Substations. Brief illustrated description of electric substation equipment as used on two interurban railroads in the United States. 700 w. Ry & Engng Rev—Jan.. 12, 1907. No. 81614.

Third Rail.

Third Rail Construction. E. Goolding. Calls attention to defects found in third-rail construction and to recent improvements in design. Ills. 1500 w. Elect'n, Lond—Jan. 11, 1907. No. 81738 A.

Tracks.

Concrete Stringers, Concrete Stringers with Ties, and Steel Ties. F. D. Jackson. Read before the N. Y. State St. Ry. Assn. Treats especially of concrete stringers with and without ties, and solid concrete in the track. Ills. 1200 w. Elec Ry Rev—Jan. 19, 1907. No. 81704.

Track Construction in Paved Streets. I. E. Matthews. Read before the N. Y. State St. Ry. Assn. Deals principally with the types of construction used in Rochester, N. Y. 2000 w. Elec Ry Rev—Jan. 19, 1907. No. 81703.

Tramways.

Some Notes on the Maintenance of Pier Tramways. H. Large. Directions for the proper care of equipment and tracks on lines at seaside towns, used only during the summer season. 2000 w. Elec Engr, Lond—Jan. 18, 1907. No. 81979 A.

Vienna.

The Electrical Equipment of the Vienna Metropolitan Railway. Describes the equipment. Ills. 1500 w. Elect'n, Lond—Jan. 4, 1907. No. 81641 A.

We supply copies of these articles. See page 999.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
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Compressed Air. *m.* New York.
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Deutsche Bauzeitung. *b-w.* Berlin.

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Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
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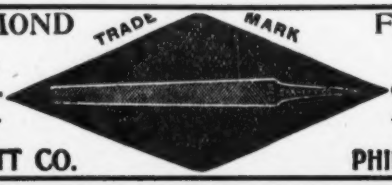

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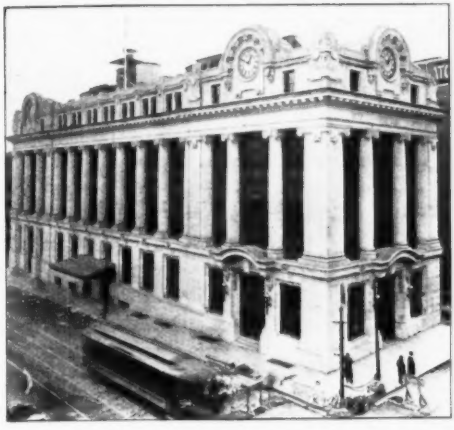

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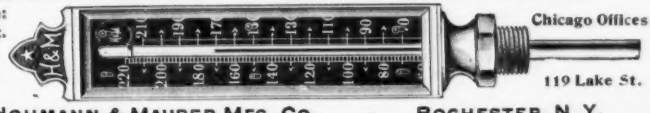

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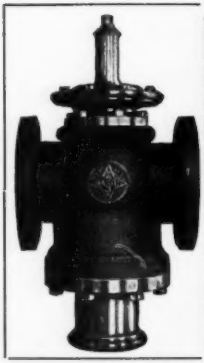

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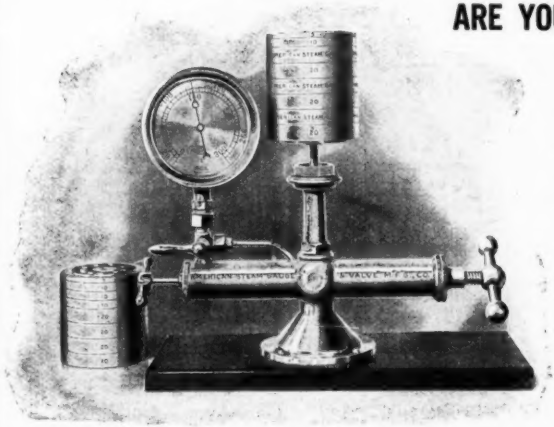

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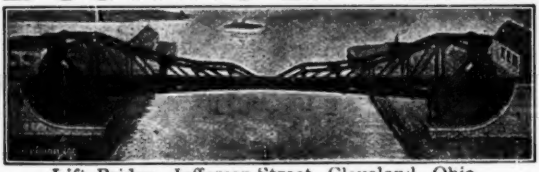

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WALTER M. McFARLAND *(Personnel—A Vital Factor in Naval Efficiency)*—Born in 1859. Educated in public schools of Washington, D. C., and at U. S. Naval Academy, where he graduated as a cadet engineer in 1879. Served on naval vessels in various parts of the world. Was assistant professor of mechanical engineering at Cornell University, by detail from the Navy; secretary of division of marine engineering of International Engineering Congress, 1893; delegate from United States Navy Department to International Congress of Naval Architects and Marine Engineers, 1897. Was twice assistant to Admiral Melville, Engineer-in-Chief, U. S. Navy, the last time as principal assistant. Member of board to reorganize personnel of United States Navy. Was promoted to grade of Chief Engineer in 1898. Resigned from the Navy in 1899, to go with the Westinghouse Electric and Manufacturing Company, of which he is acting vice-president.

W. F. WORTHINGTON *(The United States Naval Academy as an Engineering School)*—Entered U. S. Naval Academy in 1873 and graduated in 1875. Promoted to grade of Assistant Engineer, 1878; Passed Assistant Engineer, 1885; Chief Engineer, 1894; Lieutenant-Commander, 1899, and Commander, 1904. As Chief Engineer, fitted out the Lancaster, Yankee and Sterling for the war with Spain, and was on the Monitor Terror blockading Havana and assisting the landing in Porto Rico. Served as engineer on naval vessels in various parts of the world, and as Fleet Engineer on the South Atlantic, North Atlantic and Mediterranean Stations. Has been appointed to various boards connected with the Navy Department. Spent considerable time in educational work and was connected with the Engineering Department of Lafayette College, Easton, Pa., 1879; of Clemson College, S. C., 1897; and with the staff of the Naval Academy, 1885 and 1892. In 1904 was placed in charge of the construction and equipment of the U. S. Naval Experiment Station at Annapolis, which appointment he still holds.

A. E. DIXON *(The Planning and Construction of the Power Plant)*—For the past year connected with the bridge department of one of the largest American railways, and for two and a half years previously with their electrical department, on the steam and mechanical end of two great power houses under construction. For the six years prior to this association, was engaged in the design, construction, and upkeep of steel plants and blast furnaces, in which were included power plants running from 2,000 to 20,000 boiler horse power; a portion of this time was spent with various firms of consulting engineers; served also for fourteen months as master-mechanic's draftsman with a large steel company, and for eight months on the design and construction of a modern steel plant; has also had considerable experience on cranes, coal and ore-handling machinery, dredges, and some electrical work.

REGINALD PELHAM BOLTON *(Present Practice in the Use of Superheated Steam)*—Born and apprenticed in England; served as assistant engineer at the Edgemoor Iron Works and as assistant to Dr. Erasmus Leavitt; has been in practice in New York City since 1895 on the equipment of large buildings, having designed, within the last few years, the equipment of the Bowling Green offices, the Grand Central Station, the Royalton and Lorraine hotels. He originated the vertical system of electric wiring and duplex-pressure hydraulic-elevator system; has been in charge of the remodeling of the Ridgewood Pumping Station for the City of Brooklyn, before and since its incorporation with the city of New York, from 1896 to 1900; associate member of the Institution of Civil Engineers, member of the American Society of Civil Engineers, and of the American Society of Mechanical Engineers.

GERARD B. WERNER *(The Cost of Steam and of Electric Locomotive Operation)*—Graduated from Columbia College in 1903 and from Columbia University, with the degree of electrical engineer, in 1905. Spent some time in electrical research work with Prof. M. I. Pupin, and later was engaged in

the train-tests of the Interborough Rapid Transit Company under L. B. Stilwell and H. S. Putnam. Was connected with the Engineering Department of the Westinghouse Electric and Manufacturing Company for a year. At present electrical engineer with the Railway Electric Power Company, paying special attention to problems and calculations connected with electric traction and with the electrification of steam railroads. Is the author of several studies and papers on electrical subjects.

J. H. CUNTZ *(Mechanical Developments of the German Iron Industry)*—Graduated Stevens Institute (C. E., M. E.); associate editor of THE ENGINEERING MAGAZINE, 1900-1905; associated editor of the Engineering Index, in charge of the preparation of the quinquennial volumes III and IV; in expert and consulting practice in patent matters, 1905 to date; editor and manager, the Stevens Indicator; associate of the American Institute of Electrical Engineers, member of the American Association for the Advancement of Science, fellow of the American Geographical Society.

RODOLPHE MATHOT *(The Choice of Motive Power for the Workshop)*—A consulting engineer, at present resident in Brussels, Belgium; specialist in gas-producing machinery and gas and other internal-combustion engines; member of the Institution of Mechanical Engineers, of the Société des Ingénieurs Civils de France, etc.; author of the recently published work "Gas Engines and Producer-Gas Plants" (Norman W. Henley, 1905), which received a most flattering introduction from Mr. Dugald Clerk.

C. E. KNOEPPEL *(Cost Reduction through Cost Comparison)*—Born in Milwaukee, Wis., 1881. Educated in the Public Schools of Buffalo, N. Y. Spent a year in a technical school in that city. Removed to Oswego, N. Y., and was for two years employed as a moulder in the foundry of the Ames Iron Works. Was employed as draftsman and designer for two years by the Buffalo Forge Company, Buffalo, N. Y., and for one year by the Parkhurst Compound Steam Boiler Company of Oswego. Was later connected with the Department of Expert Systematizing of the Library Bureau, Boston, and has been a student and a specialist in costing methods for six years past. Is at present office manager for Clark Bros. Company, Belmont, N. Y.

CHARLES U. CARPENTER *(Profit-Making in Shop and Factory Management)*—A graduate of Princeton University with the degrees of mechanical and electrical engineer, has had a large experience in mining engineering and electrical manufacturing and in the supervision of large manufacturing plants; for some years he was factory supervisor and afterwards head of the labor department of the National Cash Register Company, Dayton, Ohio, U. S. A. Later took a similar position with the Herring-Hall-Marvin Safe Company, rising rapidly to the presidency of the concern.

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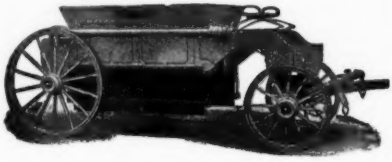

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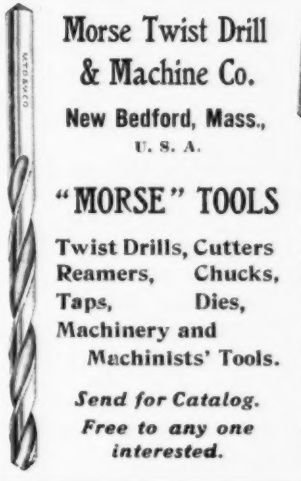

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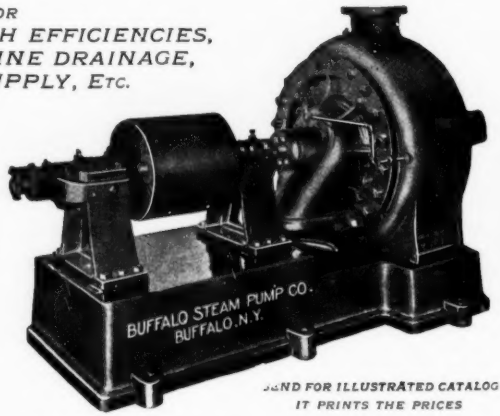

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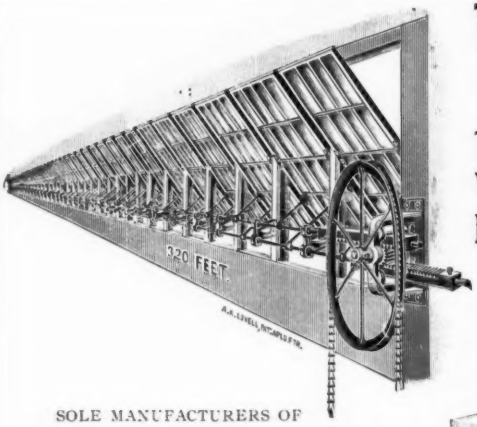

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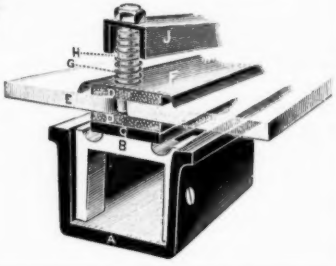

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Belt Conveyors.
Jeffrey Mfg. Co., Columbus.
H. W. Caldwell & Son Co., Chicago.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.
Webster Mfg. Co., Chicago.

Belt Dressing (Waterproof).
Jos. Dixon Crucible Co., Jersey City.

Belting.
Boston Belting Co., Boston.
Eureka Fire Hose Co., New York.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago.
Main Belting Co., Philadelphia.

Belt Lacing.
Bristol Co., Waterbury, Conn.
Robins Conveying Belt Co., N. Y.

Belt Shifters.
Mason Regulator Co., Boston.

Bending Rolls.
Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
Niagara Mch. & Tool Wks., Buffalo.
Niles-Bement-Pond Co., New York.
William Sellers Co., Inc., Phila.
Williams, White & Co., Moline.

Bitulithic Pavement.
Warren Bros. Co., Boston.

Blast Furnaces.
Walter Kennedy, Pittsburg.
G. W. McClure, Son & Co., Pittsburg.
Riter-Conley Mfg. Co., Pittsburg.

Blocks, Tackle.
Lane Bros. Co., Poughkeepsie, N. Y.

Blowers.
Allis-Chalmers Co., Milwaukee.
American Blower Co., Detroit.
American Gas Furnace Co., N. Y.
Buffalo Forge Co., Buffalo.
Crocker-Wheeler Co., Ampere, N. J.
Green Fuel Economizer Co., Matteawan, N. Y.
Massachusetts Fan Co., Waltham, Mass.
Ohio Blower Co., Cleveland.
Platt Iron Works, Dayton, Ohio.
B. F. Sturtevant Co., Hyde Park, Mass.
Western Electric Co., Chicago.

Blowers, Turbine.
De La Val Steam Turbine Co., Trenton.

Blue Prints.
A. S. Aloe Co., St. Louis.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.

Blue Print Machinery.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.
J. H. Wagenhorst & Co., Youngstown.

Boiler Feeders.
Lunkenheimer Co., Cincinnati.
Hancock Inspirator Co., N. Y.
Hayden & Derby Mfg. Co., N. Y.

Boiler Fronts and Fittings.
Ashcroft Mfg. Co., N. Y.
Consolidated Safety Valve Co., N. Y.
Continental Iron Works, Brooklyn.
Hancock Inspirator Co., N. Y.
Hayden & Derby Mfg. Co., N. Y.
Lunkenheimer Co., Cincinnati.
Mecklenburg Iron Works, Charlotte, N. C.
Walworth Mfg. Co., Boston.

Boiler Inspection and Insurance.
Casualty Co. of America, New York.
Maryland Casualty Co., Baltimore.

Boilers.
Atlantic Works, East Boston, Mass.
Atlas Engine Works, Indianapolis.
Babcock & Wilcox Co., New York.
Harrison Safety Boiler Wks., Phila.
Heine Safety Boiler Co., St. Louis.
Maryland Casualty Co., Baltimore.
Oil Well Supply Co., Oswego, N. Y.
Platt Iron Works, Dayton, Ohio.
Platt & Co., John, New York.
Riter-Conley Mfg. Co., Pittsburg.
Robb-Mumford Boiler Co., So. Framingham, Mass.
Struthers-Wells Co., Warren, Pa.
Sam'l Smith & Son Co., Paterson, N. J.
Tippett & Wood, Phillipsburg, N. J.
Walsh's Boiler Wks., Holyoke, Mass.
Robt. Wetherill & Co., Chester, Pa.

Bolts and Nuts.
Cleveland Cap Screw Co., Cleveland.

Bolt and Nut Machinery.
Niles-Bement-Pond Co., New York.

Boosters.
Allis-Chalmers Co., Milwaukee.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Western Electric Co., Chicago.

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Boring Mills.
Niles-Bement-Pond Co., New York.
William Sellers Co., Inc., Phila.
Williams, White & Co., Moline.

Brakes—Friction.
Elec. Controller & Supply Co., Cleveland.

Brass Founders' Supplies.
Geo. F. Blake Mrg. Co., New York.
S. Obermayer Co., Cincinnati.

Brass Makers' Lathes.
Am. Tool & Machine Co., Boston.
Niles-Bement-Pond Co., New York.

Breast Drill, Electric.
Jas. Clark, Jr., & Co., Louisville.

Brick.
Henry Maurer & Son, New York.

Brick and Tile Machinery.
American Blower Co., Detroit.
Jeffrey Mfg. Co., Columbus.

Bridges, Roofs, Etc.
Aberthaw Construction Co., Boston.
Berlin Construction Co., Berlin, Conn.
Brown Hoisting Mchy. Co., Cleveland.
Cowing Engineering Co., Cleveland.
Curtin-Ruggles Co., New York.
Fawcus Machine Co., Pittsburg.
Interstate Engineering Co., Cleveland.
Riter-Conley Mfg. Co., Pittsburg.
Tippett & Wood, Phillipsburg, N. J.
Trussed Concrete Steel Co., Detroit.
Tucker & Vinton, New York.
Wallace-Coates Eng'g Co., Chicago.
Walsh's Boiler Wks., Holyoke, Mass.

Bronze Castings.
J. B. Chapman & Co., Springfield, Mass.
Julian D'Este Co., Boston.

Bucket Elevators.
Allis-Chalmers Co., Milwaukee.
Hayward Co., The, New York.
Jeffrey Mfg. Co., Columbus.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.
Webster Mfg. Co., Chicago.

Buildings, Iron, Steel and Steel Concrete.
Aberthaw Construction Co., Boston.
Berlin Construction Co., Berlin, Conn.
Brown Hoisting Mchy. Co., Cleveland.
Curtin-Ruggles Co., New York.
Interstate Engineering Co., Cleveland.
Ransome & Smith Co., New York.
Trussed Concrete Steel Co., Detroit.
Tucker & Vinton, New York.
Turner Construction Co., New York.

Bulldozers.
Niles-Bement-Pond Co., New York.
Williams, White & Co., Moline.

Bunkers, Coal, Ore, etc.
A. Samuel Berquist, Brooklyn.

Business Systems.
John A. Cooper, Chicago.
Gunn, Richards & Co., New York.
Library Bureau, New York.
Stephen T. Williams & Staff, N. Y.

Cable-Railway Machinery.
Mead-Morrison Mfg. Co., Boston.
Poole Eng'g & Mch. Co., Baltimore.
Robins Conveying Belt Co., N. Y.

Cables, Elec. & Submarine.
General Electric Co., New York.
Sprague Electric Co., New York.
Western Electric Co., Chicago.

Cableways—
(See Aerial Tramways.)

Cables, Wire.
Lidgerwood Mfg. Co., New York.
Trenton Iron Co., Trenton, N. J.

Calculating Machines.
Felt & Tarrant Mfg. Co., Chicago.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.

Carborundum.
Carborundum Co., Niagara Falls, N.Y.

Cars.
Arthur Koppel Co., New York.
Browning Engineering Co., Cleveland.
Industrial Engineering Co., Cleveland.
Mead-Morrison Mfg. Co., Boston.
Mecklenburg Iron Wks., Charlotte, N. C.

Car Shop Machinery.
Fay & Egan Co., Cincinnati.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.

Castings, Iron, Steel & Brass.
Buffalo Foundry Co,. Buffalo.
H. W. Caldwell & Son Co., Chicago.
J. B. Chapman & Co., Springfield, Mass.
Fawcus Machine Co., Pittsburg.
Stanley G. Flagg & Co., Phila.
Lunkenheimer Co., Cincinnati.
Jeffrey Mfg. Co., Columbus.
Mecklenburg Iron Works, Charlotte, N. C.
Poole Eng'g & Mch. Co., Baltimore.
Southwalk Fdy. & Mch. Co., Phila.
Walworth Mfg. Co., Boston.
Robt. Wetherill & Co., Chester, Pa.

Cast-Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co., Phila.
Walworth Mfg. Co., Boston.
R. D. Wood & Co., Phila.

Cement Machinery.
Allis-Chalmers Co., Milwaukee.
Automatic Weighing Machine Co., Newark.
Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
Bradley Pulverizer Co., Boston.
H. W. Caldwell & Sons Co., Chicago.
W. D. Dunning, Syracuse, N. Y.
Jeffrey Mfg. Co., Columbus.
Lehigh Car, Wheel & Axle Works, Catasauqua, Pa.
Link-Belt Co., Phila.
Mead-Morrison Mfg. Co., Boston.
Ransome Concrete Mchy. Co., N. Y.
Robins Conveying Belt Co., N. Y.
Ruggles-Coles Eng'g Co., New York.
F. L. Smidth & Co., New York.
Vulcan Iron Works, Wilkes-Barre, Pa.
Webster Mfg. Co., Chicago.

Cement, Portland.
Alsen's Am. Portland Cement Co., New York.
American Cement Co., Phila.
Atlas Portland Cement Co., N. Y.
Empire Portland Cement Co., Warners, N. Y.
Glens Falls Portland Cement Co., Glens Falls, N. Y.
Lehigh Portland Cement Co., Allentown, Pa.

Chains.
Diamond Chain & Mfg. Co., Indianapolis.
Morse Chain Co., Ithaca, N. Y.

Chain Belting.
H. W. Caldwell & Sons Co., Chicago.
Jeffrey Mfg. Co., Columbus.
Link-Belt Eng'g Co., Phila.
Morse Chain Co., Ithaca, N. Y.
Webster Mfg. Co., Chicago.

Chain Joint.
Morse Chain Co., Trumansburg, N. Y.

Channeling Machines.
Ingersoll-Rand Co., New York.
Sullivan Machinery Co., Chicago.

Checks, Time, Pay & Trade.
American Ry. Supply Co., New York.
Schwerdtle Stamp Co., Bridgeport.

Chemicals.
Roessler & Hasslacher Chem. Co.,

Chemists.
Chas. Catlett, Staunton, Va.
Robt. W. Hunt & Co., Chicago.
Lunkenheimer Co., Cincinnati.

Chucks.
Almond Mfg. Co., Brooklyn.
American Tool & Mch. Co., Boston.
Niles-Bement-Pond Co., New York.

Clutches, Magnetic.
Elec. Controller & Supply Co., Cleveland.

Clutch Pulleys.
H. W. Caldwell & Sons Co., Chicago.

Coal and Ashes-Handling Machinery.
Browning Engineering Co., Cleveland.
Brown Hoisting Mchy. Co., Cleveland.
H. W. Caldwell & Sons Co., Chicago.
Hayward Co., New York.
C. W. Hunt Co., New York.
Interstate Engineering Co., Cleveland.
Jeffrey Mfg. Co., Columbus.
Arthur Koppel Co., New York.
Lidgerwood Mfg. Co., New York.
Link-Belt Eng'g Co., Phila.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.
Webster Mfg. Co., Chicago.

Coal Cutters (Air and Electric).
Ingersoll-Rand Co., New York.
Jeffrey Mfg. Co., Columbus.
Sullivan Machinery Co., Chicago.

Coal and Ore Bunkers.
A. Samuel Berquist, Brooklyn.

Coal Weighing Machine, Automatic.
Automatic Weighing Machine Co., Newark.
Richardson Scale Co., New York.

Coal-Mining Machinery.
Allis-Chalmers Co., Milwaukee.
Geo. F. Blake Mfg. Co., New York.
General Electric Co., New York.
C. W. Hunt Co., New York.
Ingersoll-Rand Co., New York.
Interstate Engineering Co., Cleveland.
Jeffrey Mfg. Co., Columbus.
Knowles Steam Pump Wks., N. Y.
Arthur Koppel Co., New York.
Laidlaw-Dunn-Gordon Co., New York.
Lambert Hoist. Engine Co., Newark.
Link-Belt Eng'g Co., Phila.
John H. McGowan Co., Cincinnati.
Norwalk Iron Wks., So. Norwalk, Ct.
Robins Conveying Belt Co., N. Y.
Sullivan Machinery Co., Chicago.
Westinghouse Elec. & Mfg. Co., Pittsburg.
Henry R. Worthington, New York.

Coal Screens.
Allis-Chalmers Co., Milwaukee.
Hendrick Mfg. Co., Carbondale, Pa.
Jeffrey Mfg. Co., Columbus.
Link-Belt Eng'g Co., Phila.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.
W. S. Tyler Co., Cleveland.

Cocks.
Golden-Anderson Valve Specialty Co., Pittsburg.
Lunkenheimer Co., Cincinnati.

Coil Pipe.
Whitlock Coil Pipe Co., Hartford.

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Commercial Trucks, Gasoline.
Industrial Engineering Co., Cleveland.

Compound Jacks.
Joyce, Cridland Co., Dayton.

Comptometers.
Felt & Tarrant Mfg. Co., Chicago.

Concrete Mixers.
Dobbie Foundry & Machine Co., Niagara Falls.
W. D. Dunning, Syracuse, N. Y.
Jeffrey Mfg. Co., Columbus.
Ransome Concrete Mchy. Co., N. Y.

Condensers.
Alberger Condenser Co., New York.
Allis-Chalmers Co., Milwaukee.
Geo. F. Blake Mfg. Co., New York.
Deane Steam Pump Co., New York.
Epping-Carpenter Co., Pittsburg.
Guild & Garrison, Brooklyn.
Knowles Steam Pump Wks., N. Y.
Laidlaw-Dunn-Gordon Co., N. Y.
John H. McGowan Co., Cincinnati.
Platt Iron Works, Dayton, Ohio.
Snow Steam Pump Wks., New York
Southwark Fdy. & Mch. Co., Phila.
Struthers-Wells Co., Warren, Pa.
Wheeler Condenser & Eng'g Co., N.Y.
Henry R. Worthington, New York.

Continuous Elevators.
H. W. Caldwell & Son Co., Chicago.

Contractors, General.
Curtin-Ruggles Co., New York.
Fawcus Machine Co., Fittsburg.
Ransome & Smith Co., N. Y.
Trussed Concrete Steel Co., Detroit.
Turner Construction Co., New York.
J. G. White & Co., New York.
Tucker & Vinton, New York.

Conduit Systems.
G. M. Gest, New York.

Controllers.
Cutler-Hammer Mfg. Co., Milwaukee.
Elec. Controller & Supply Co., Cleveland.

Conveying Machinery.
Allis-Chalmers Co., Milwaukee.
Browning Engineering Co., Cleveland.
Brown Hoisting Mchy. Co., Cleveland.
H. W. Caldwell & Sons Co., Chicago.
Dobbie Foundry & Machine Co., Niagara Falls.
Frick Co., Waynesboro, Pa.
Hayward Co., The, New York.
C. W. Hunt Co., New York.
Interstate Engineering Co., Cleveland.
Jeffrey Mfg. Co., Columbus.
Arthur Koppel Co., New York.
Lidgerwood Mfg. Co., New York.
Link-Belt Eng'g Co., Phila.
Maris Bros., Philadelphia.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.
Trenton Iron Co., Trenton, N. J.
Webster Mfg. Co., Chicago.

Cooling Towers.
Alberger Condenser Co., New York.
George Stocker, St. Louis.
Wheeler Condenser & Eng'g Co., N. Y.
Henry R. Worthington, New York.

Coppersmiths.
J. B. Chapman & Co., Springfield, Mass.

Cordage.
American Mfg. Co., New York.

Cost Systems.
John A. Cooper, Chicago.
Gunn, Richards & Co., New York.
C. K. Hooper, New York.
Library Bureau, New York.
Stephen T. Williams & Staff, N. Y.

Cotton Oil Machinery.
Laidlaw-Dunn-Gordon Co., New York.
Platt Iron Works, Dayton, Ohio.

Couplings.
Almond Mfg. Co., Brooklyn.

Cranes.
Brown Hoisting Mchy. Co., Cleveland.
Brown Hoist. Mch. Co., N. Y.
Browning Engineering Co., Cleveland.
Dobbie Foundry & Machine Co., Niagara Falls.
Hayward Co., The, New York.
Industrial Works, Bay City, Mich.
Interstate Engineering Co., Cleveland.
Maris Bros., Philadelphia.
Niles-Bement-Pond Co., New York.
Riter-Conley Mfg. Co., Pittsburg.
R. D. Wood & Co., Phila.

Crane Motors.
Browning Engineering Co., Cleveland.
Western Electric Co., Chicago.

Crane Scales.,
Buffalo Scale Co., Buffalo.

Crucibles.
Jos. Dixon Crucible Co., Jersey City.
S. Obermayer Co., Cincinnati.

Crusher, Ore, Phosphate, Rock.
Allis-Chalmers Co., Milwaukee.
Jeffrey Mfg. Co., Columbus.
Lehigh Car, Wheel & Axle Works, Catasauqua, Pa.
F. L. Smidth & Co., New York.

Cupolas.
S. Obermayer Co., Cincinnati.
Riter-Conley Mfg. Co., Pittsburg.

Cutters, Milling.
Becker-Brainard Mill Mch. Co., Hyde Park, Mass.
Pratt & Whitney Co., Hartford.

Damper Regulator.
Julian D'Este Co., Boston.
Mason Regulator Co., Boston.

Derricks and Fittings.
Browning Engineering Co., Cleveland.
Brown Hoisting Mchy. Co., Cleveland.
Contractors' Plant Mfg. Co., Buffalo.
Dobbie Foundry & Machine Co., Niagara Falls.

Digesters.
Atlantic Works, East Boston, Mass.
Riter-Conley Mfg. Co., Pittsburg.
Tippett & Wood, Phillipsburg, N. J.
Robt. Wetherill & Co., Chester, Pa.

Draft, Mechanical.
Buffalo Forge Co., Buffalo.
B. F. Sturtevant Co., Hyde Park, Mass.

Drilling Machines.
American Tool Works Co., Cincinnati.
W. F. & J. Barnes Co., Rockford, Ill.
Chicago Pneu. Tool Co., Chicago.
Jas. Clark, Jr., & Co., Louisville.
Ingersoll-Rand Co., New York.
Keystone Traction Drill Co., Beaver Falls, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.
William Sellers Co., Inc., Phila.
Stow Flexible Shaft Co., Phila.
Stow Mfg. Co., Binghamton, N. Y.

Drills, Diamond Core.
Ingersoll-Rand Co., New York.
Sullivan Machinery Co., Chicago.

Drills—Rock and Coal.
Am. Diamond Rock Drill Co., N. Y.
Chicago Pneumatic Tool Co., Chicago.
Clayton Air Compress Wks., N. Y.
Hall Steam Pump Co., Pittsburg.
Ingersoll-Rand Co., New York.
Jeffrey Mfg. Co., Columbus
Keystone Traction Drill Co., Beaver Falls, Pa.
F. L. Smidth & Co., New York.
Sullivan Machinery Co., Chicago.
Wood Drill Works, Paterson.

Drop Forgings.
Anderson Forge & Machine Co., Detroit, Mich.
Chicago Drop Forge & Fdy Co., Kensington, Ill.
Wyman & Gordon, Worcester, Mass.

Drop Hammers.
Williams, White & Co., Moline.

Drying Apparatus.
Buffalo Forge Co., Buffalo.
B. F. Sturtevant Co., Hyde Park, Mass.

Dumps, Automatic.
Jeffrey Mfg. Co., Columbus.
Sullivan Machinery Co., Chicago.

Dump Wagons.
Troy Wagon Works Co., Troy, Ohio.

Dust Collecting Systems.
Ohio Blower Co., Cleveland.

Dynamos.
Allis-Chalmers Co., Milwaukee.
Barriett Elec. Mfg. Co., Cincinnati.
Crocker-Wheeler Co., Ampere, N. J.
C & C Electric Co., New York.
General Electric Co., New York.
Jeffrey Mfg. Co., Columbus.
Lincoln Motor Works Co., Cleveland.
Northern Elec. Mfg. Co., Madison.
B. F. Sturtevant Co., Hyde Park, Mass.
Westinghouse Elec. & Mfg. Co., Pittsburg.
Western Electric Co., Chicago.

Dynamos, Steam Turbine.
De La Val Steam Turbine Co., Trenton.

Elbows, Pipe.
Lunkenheimer Co., Cincinnati.
Whitlock Coil Pipe Co., Hartford.

Electric Bells.
W. R. Ostrander & Co., New York.
Western Electric Co., Chicago.

Electric Grinder.
Hisey-Wolf Machine Co., Cincinnati.

Electric Heating Apparatus.
Simplex Elec. Heating Co., Cambridgeport, Mass.
Western Electric Co., Chicago.

Electric Hoists.
Allis-Chalmers Co., Milwaukee.
Brown Hoisting Mchy. Co., Cleveland.
Browning Engineering Co., Cleveland.
C & C Electric Co., New York.
C. W. Hunt Co., New York.
Dobbie Foundry & Machine Co., Niagara Falls.
Lambert Hoist. Eng. Co., Newark.
Lidgerwood Mfg. Co., New York.
Mead-Morrison Mfg. Co., Boston.
Mineral Ridge Mfg. Co., Mineral Ridge, Ohio.
Niles-Bement-Pond Co., New York.
Western Electric Co., Chicago.

Electrical Furnaces.
Charles Engelhard, New York.

Elec. Measuring Instruments.
Weston Elec. Instrument Co., Waverly Park, Newark, N. J.

Elec. Welding Outfits.
C & C Electric Co., New York.

Elevating and Conveying Mchy.
Dobbie Foundry & Machine Co., Niagara Falls.
Jeffrey Mfg. Co., Columbus.
Webster Mfg. Co., Chicago.

Elevator Insurance.
Maryland Casualty Co., Baltimore.

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Elevators.

H. W. Caldwell & Son Co., Chicago.
Electric Welding Mfg. Co., Pittsburg.
Jeffrey Mfg. Co., Columbus.
Link-Belt Eng'g Co., Phila.
S. Obermayer Co., Cincinnati.
Poole Eng'g Mch. Co., Baltimore.

Elevator Pressure Regulator.

Mason Regulator Co., Boston.

Employers' Liability Insurance.

Maryland Casualty Co., Baltimore.

Engineering Instruments.

A. S. Aloe Co., St. Louis.
Theo. Alteneder & Sons, Phila.
Brandis Sons Co., Brooklyn.
Buff & Buff Mfg. Co., Boston.
Eugene Dietzgen Co., Chicago.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.
Queen & Co., Phila.
Young & Sons, Philadelphia.

Engineers.

George M. Brill, Los Angeles.
Arnold Co., Chicago.
Abner Doble Co., San Francisco.
Carl R. Green, Dayton, O.
Dodge & Day, Philadelphia.
Fawcus Machine Co., Pittsburg.
Gunn, Richards & Co., New York.
G. K. Hooper, New York.
Illmer & Co., Cincinnati.
Industrial Engineering Co., Cleveland.
Robt. McF. Doble, Colorado Springs, Colo.
Robt. W. Hunt & Co., Chicago.
Julian Kennedy, Pittsburg.
Walter Kennedy, Pittsburg.
G. W. McClure, Son & Co., Pittsburg.
H. F. J. Porter, New York.
W. K. Palmer, Kansas City.
Power Installation Co., Buffalo.
A. W. Robinson, Montreal, Canada.
H. B. Roelker, New York.
Wallace-Coates Eng'g Co., Chicago.
J. G. White & Co., New York.
Stephen T. Williams & Staff, N. Y.

Engines, Blowing.

Allis-Chalmers Co., Milwaukee.
American Blower Co., Detroit.
Platt Iron Works, Dayton, Ohio.
Southwark Fdy. & Mch. Co., Phila.
Sprague Elec. Co., New York.

Engines, Marine.

Atlantic Works, East Boston, Mass.

Engines—Gas and Gasoline.

Allis-Chalmers Co., Milwaukee.
De La Vergne Machine Co., N. Y.
Fairbanks Co., New York.
Snow Steam Pump Wks., New York.
Struthers-Wells Co., Warren, Pa.
Westinghouse Mch. Co., Pittsburg.
Westinghouse, Church, Kerr & Co., New York.

Engines, Steam.

Allis-Chalmers Co., Milwaukee.
American Blower Co., Detroit.
Atlas Engine Works, Indianapolis.
Ball Engine Co., Erie, Pa.
Brown Hoisting Mchy. Co., Cleveland.
Geo. F. Blake Mfg. Co., New York.
Buffalo Forge Co., Buffalo.
Frick Co., Waynesboro, Pa.
Harrisburg Fdy & Mch. Wks., Harrisburg, Pa.
Hooven, Owens, Rentschler Co., Hamilton.
Mecklenburg Iron Wks., Charlotte, N. C.
Ohio Blower Co., Cleveland.
Providence Eng'g Wks., Providence.
Shepherd Eng'g Co., Franklin, Pa.
Southwark Fdy. & Mch. Co., Phila.
Struthers-Wells Co., Warren, Pa.
B. F. Sturtevant Co., Hyde Park, Mass.
Westinghouse Mch. Co., Pittsburg.
Westinghouse, Church, Kerr & Co., New York.
Robt. Wetherill & Co., Chester, Pa.

Engineering Specialties.

Golden-Anderson Valve Specialty Co., Pittsburg.
Julian D'Este Co., Boston.
Lunkenheimer Co., Cincinnati.

Evaporators.

Geo. F. Blake Mfg. Co., New York.
Knowles Steam Pump Wks., N. Y.

Excavators.

Allis-Chalmers Co., Milwaukee.
Browning Engineering Co., Cleveland.
Bucyrus Co., So. Milwaukee, Wis.
Hayward Co., The, New York.
Jeffrey Mfg. Co., Columbus.
Marion Steam Shovel Co., Marion, O.
Robins Conveying Belt Co., N. Y.

Exhaust Heads.

Am. Spiral Pipe Wks., Chicago.
Direct Separator Co., Syracuse.
Hoppes Mfg. Co., Springfield, O.
B. F. Sturtevant Co., Hyde Park, Mass.
Watson & McDaniel Co., Phila.
Wright Mfg. Co., Detroit.

Exhaust Heads, (Cast Iron).

Ohio Blower Co., Cleveland.

Expanded Metal.

Associated Expanded Metal Cos., N. Y.
Roebling Construction Co., N. Y.

Fans, Ventilating.

Allis-Chalmers Co., Milwaukee.
American Blower Co., Detroit.
Buffalo Forge Co., Buffalo.
Green Fuel Economizer Co., Matteawan, N. Y.
Massachusetts Fan Co., Waltham, Mass.
Power Specialty Co., New York.
B. F. Sturtevant Co., Hyde Park, Mass.
Sullivan Machinery Co., Chicago.
Western Electric Co., Chicago.

Fans, Electric.

Diehl Mfg. Co., Elizabethport, N. J.
Western Electric Co., Chicago.

Feed Water Controllers.

Strong, Carlisle & Hammond Co., Cleveland.

Feed-Water Heaters and Purifiers.

Allis-Chalmers Co., Milwaukee.
Geo. F. Blake Mfg. Co., New York.
I. B. Davis & Son, Hartford.
Goubert Mfg. Co., New York.
Green Fuel Economizer Co., Matteawan, N. Y.
Harrison Safety Boiler Wks., Phila.
Hoppes Mfg. Co., Springfield, O.
Knowles Steam Pump Wks., N. Y.
John H. McGowan Co., Cincinnati.
The Petroleum Iron Works Co., Washington, Pa.
Platt Iron Works Co., Dayton.
Providence Eng'g Wks., Providence.
Ross Valve Co., Troy.
Wm. B. Scaife & Sons Co., Pittsburg.
Stewart Heater Co., Buffalo.
Warren Webster & Co., Camden, N. J.
Whitlock Coil Pipe Co., Hartford.
Robt. Wetherill & Co., Chester, Pa.
Wheeler Condenser & Eng'g Co., N. Y.
Henry R. Worthington, New York.

Feed Water Regulators.

Chaplin-Fulton Mfg. Co., Pittsburg.
Strong, Carlisle & Hammond Co., Cleveland.
Williams Gauge Co., Pittsburg.

Felt, Waterproof.

Hydrex Felt & Eng'g Co., New York.

Files and Rasps.

G. & H. Barnett Co., Phila.
Nicholson File Co., Providence.

Filing Cabinets.

Globe-Wernicke Co., Cincinnati.
Library Bureau, New York.

Filter Presses.

Am. Tool & Machine Co., Boston.
Niles-Bement-Pond Co., New York.

Filters.

L. O. Koven & Bro., New York.
Ross Valve Co., Troy.
Wm. B. Scaife & Sons Co., Pittsburg.
Robt. Wetherill & Co., Chester, Pa.

Fire Brick.

Henry Maurer & Son, New York.
S. Obermayer Co., Cincinnati.

Fireproof Building Materials.

Associated Expanded Metal Co., N. Y.
Clinton Wire Cloth Co., New York.
Henry Maurer & Son, New York.
Roebling Construction Co., New York.

Fittings.

Pittsburg Valve & Fittings Co., Pittsburg.

Flanges.

E. M. Dart Mfg. Co., Providence.
Lunkenheimer Co., Cincinnati.

Flanges—Forged Steel.

Am. Spiral Pipe Wks., Chicago.

Flexible Shafts.

Stow Flexible Shaft Co., Phila.
Stow Mfg. Co., Binghamton, N. Y.

Flexible Steel Tubing.

Almond Mfg. Co., Brooklyn.

Float Valves.

Foster Eng'g Co., Newark.
Golden-Anderson Valve Specialty Co., Pittsburg.

Floor and Sidewalk Lights.

T. H. Brooks & Co., Cleveland.

Fly Wheel Insurance.

Maryland Casualty Co., Baltimore.

Fly Wheels.

Allis-Chalmers Co., Milwaukee.
Poole Eng'g & Mch. Co., Baltimore.
Robt. Wetherill & Co., Chester, Pa.

Forges.

Buffalo Forge Co., Buffalo.
Ingersoll-Rand Co., New York.
B. F. Sturtevant Co., Hyde Park, Mass.

Forgings, Iron and Steel.

Anderson Forge & Machine Co., Detroit, Mich.
Chicago Drop Forge & Fdy. Co., Kensington, Ill.
Fawcus Machine Co., Pittsburg.
Wyman & Gordon, Worcester.

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Foundry Equipment.
Am. Air Compressor Wks., New York.
Geo. F. Blake Mfg. Co., New York.
Buffalo Foundry Co., Buffalo.
C. W. Hunt Co., New York.
Ingersoll-Rand Co., New York.
Arthur Koppel Co., New York.
S. Obermayer Co., Cincinnati.

Foundry Supplies.
Ingersoll-Rand Co., New York.
S. Obermayer Co., Cincinnati.

Friction Clutches.
Am Tool & Mch. Co., Boston.
H. W. Caldwell & Son Co., Chicago.
Cutler-Hammer Mfg. Co., Milwaukee.
Elec. Controller & Supply Co., Cleveland.
Link-Belt Eng'g Co., Phila.
Poole Eng'g & Mch. Co., Baltimore.

Fuel Economizers.
Green Fuel Economizer Co., Matteawan, N. Y.
Providence Eng'g Wks., Providence.
B. F. Sturtevant Co., Hyde Park, Mass.

Furnace Builders.
Am. Gas Furnace Co., New York.
Continental Iron Wks., Brooklyn.
Julian Kennedy, Pittsburg.
G. W. McClure, Son & Co., Pittsburg.
Morgan Const. Co., Worcester.
Riter-Conley Mfg. Co., Pittsburg.

Gages — Pressure, Steam, Water.
American Steam Gauge & Valve Mfg. Co., Boston.
Ashcroft Mfg. Co., N. Y.
Ashton Valve Co., Boston.
Bristol Co., Waterbury Conn.
Golden-Anderson Valve Specialty Co., Pittsburg.
Hohmann & Maurer Mfg. Co., Rochester.
Lunkenheimer Co., Cincinnati.
Manning, Maxwell & Moore, N. Y.
Star Brass Mfg. Co., Boston.
Walworth Mfg. Co., Boston.

Galvanizing.
L. O. Koven & Bro., New York.

Gas Arc Lamps.
General Gas Light Co., Kalamazoo, Mich.

Gas Blowers and Exhausters.
Buffalo Forge Co., Buffalo.
B. F. Sturtevant Co., Hyde Park, Mass.

Gas-Composimeters.
Uehling Instrument Co., Passaic, N. J.

Gas Engines.
Wile Power Gas Co., Rochester.

Gas Engine Experts.
Illmer & Co., Cincinnati.

Gas Engine Valves.
Cleveland Cap Screw Co., Cleveland.

Gas Machines & Generators.
Am. Gas Furnace Co., New York.
Morgan Const. Co., Worcester.
Walworth Mfg. Co., Boston.
Wile Power Gas Co., Rochester.
R. D. Wood & Co., Phila.

Gas Producers.
Morgan Construction Co., Worcester.
Wile Power Gas Co., Rochester.

Gaskets.
Am. Spiral Pipe Wks., Chicago.
Boston Belting Co., Boston.

Gear Cutting Machines.
Becker-Brainard Mill. Mch. Co., Hyde Park, Mass.
Pratt & Whitney Co., Hartford.

Geared Jacks.
Joyce, Cridland Co., Dayton.

Gearing.
Hugo Bilgram, Phila.
Geo. F. Blake Mfg. Co., New York.
Buffalo Gear & Pattern Wks., Buffalo.
H. W. Caldwell & Son Co., Chicago.
Fawcus Machine Co., Pittsburg.
Wm. Ganschow, Chicago.
Jeffrey Mfg. Co., Columbus.
New Process Rawhide Co., Syracuse.
R. D. Nuttall Co., Pittsburg.
Poole Eng'g & Mch. Co., Baltimore.
Wm. Sellers Co., Inc., Phila.
Stow Flexible Shaft Co., Phila.
Robt. Wetherill & Co., Chester, Pa.

General Water Damage Insurance.
Maryland Casualty Co., Baltimore.

Generating Sets.
Allis-Chalmers Co., Milwaukee.
Browning Engineering Co., Cleveland.
Buffalo Forge Co., Buffalo.
B. F. Sturtevant Co., Hyde Park, Mass.
Western Electric Co., Chicago.

Gold Dredging Machinery.
Allis-Chalmers Co., Milwaukee.
Risdon Iron Works, San Francisco.

Graphite.
Jos. Dixon Crucible Co., Jersey City.
S. Obermayer Co., Cincinnati.

Grates, Traveling Link.
Green Engineering Co., Chicago.

Grinding Machinery.
Hisey-Wolf Machine Co., Cincinnati.
Western Electric Co., Chicago.

Grinding & Polishing Mchy.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Jas. Clarke, Jr., & Co., Louisville.
Crocker-Wheeler Co., Ampere, N. J.
Landis Tool Co., Waynesboro, Pa.
Niles-Bement-Pond Co., New York.
Northern Elec. Mfg. Co., Madison.
Pratt & Whitney Co., Hartford.
Stow Flexible Shaft Co., Phila.
Stow Mfg. Co., Binghamton, N. Y.
William Sellers Co., Inc., Phila.

Grinding & Pulverizing Mchy.
Bradley Pulverizer Co., Boston.
W. D. Dunning, Syracuse.
Lehigh Car Wheel & Axle Works, Catasauqua, Pa.
F. L. Smidth & Co., New York.
Vulcan Iron Works, Wilkes-Barre, Pa.

Grinding Wheels (Alundum).
Norton Co., Worcester, Mass.

Hack Saws.
Niles-Bement-Pond Co., New York.

Hammers, Electric.
Northern Elec. Mfg. Co., Madison.

Heating and Vent. Apparatus.
American Blower Co., Detroit.
Buffalo Forge Co., Buffalo.
Manning, Maxwell & Moore, N. Y.
Ohio Blower Co., Cleveland.
Sprague Elec. Co., New York.
Stewart Heater Co., Buffalo.
B. F. Sturtevant Co., Hyde Park, Mass.
Walworth Mfg. Co., Boston.
Warren Webster & Co., Camden, N. J.
Western Electric Co., Chicago.

Hoisting Engines and Mchy.
Allis-Chalmers Co., Milwaukee.
Brown Hoisting Mchy. Co., Cleveland.
Brown Hoist. Mch. Co., New York.
Browning Engineering Co., Cleveland.
Contractors' Plant Mfg. Co., Buffalo.
Dobbie Foundry & Machine Co., Niagara Falls.
S. Flory Mfg. Co., Bangor, Pa.
Hayward Co., New York.
C. W. Hunt Co., New York.
Industrial Wks., Bay City, Mich.
Jeffrey Mfg. Co., Columbus.
Lane Bros. Co., Poughkeepsie, N. Y.
Lambert Hoist. Eng. Co., Newark.
Lidgerwood Mfg. Co., New York.
Link-Belt Co., Phila.
Mead-Morrison Mfg. Co., Boston.
Providence Eng'g Works, Providence.
Robins Conveying Belt Co., N. Y.
William Sellers Co., Inc., Phila.
Sullivan Machinery Co., Chicago.
Trenton Iron Co., Trenton, N. J.
Vulcan Iron Wks., Wilkes-Barre, Pa.
Western Electric Co., Chicago.

Hoisting Rope.
American Mfg. Co., New York.

Hollow Concrete Building Block Machines.
Century Cement Machine Co., Rochester.

Hose.
Chicago Pneumatic Tool Co., Chicago.
Boston Belting Co., Boston.
Eureka Fire Hose Co., New York.

Hydraulic Machinery.
Allis-Chalmers Co., Milwaukee.
Goulds Mfg. Co., Seneca Falls, N. Y.
Niles-Bement-Pond Co., New York.
Platt Iron Works, Dayton, Ohio.
Williams, White & Co., Moline.

Hydraulic Rams.
Pelton Water Wheel Co., San Francisco.
Power Specialty Co., New York.

Ice-Mak'g & Refriger. Mchy.
De La Vergne Machine Co., N. Y.
Frick Co., Waynesboro, Pa.
H. B. Roelker, New York.

India Oil Stones.
Norton Co., Worcester, Mass.

Indicators.
Ashcroft Mfg. Co., N. Y.

Industrial Methods.
John A. Cooper, Chicago.
Gunn, Richards & Co., New York.
G. K. Hooper, New York.
Library Bureau, New York.
Stephen T. Williams & Staff, New York.

Injectors.
Lunkenheimer Co., Cincinnati.

Insurance.
Maryland Casualty Co., Baltimore.

Internal Gearing.
Wm. Ganschow, Chicago.
R. D. Nuttall Co., Pittsburg.

Iron and Bronze, Ornamental.
W. S. Tyler Co., Cleveland.

Jacks, Hydraulic.
Joyce, Cridland Co., Dayton.
Watson-Stillman Co., New York.

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Kiln.

Vulcan Iron Wks., Wilkes-Barre, Pa.

Lamps, Electric.

General Electric Co., New York.
Sawyer-Man Elec. Co., Pittsburg.
Westinghouse Elec. & Mfg. Co., Pittsburg.
Western Electric Co., Chicago.

Lamps, Shop.

General Gas Light Co., Kalamazoo, Mich.

Lathes.

American Tool & Mch. Co., Boston.
American Tool Works Co., Cincinnati.
W. F. & J. Barnes Co., Rockford, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.
Tindell-Morris Co., Eddystone, Pa.
William Sellers Co., Inc., Phila.

Law, Mining.

John J. Cushing, New York.

Lever Jacks.

Joyce, Cridland Co., Dayton.

Lift Bridges.

Cowing Engineering Co., Cleveland.
Fawcus Machine Co., Pittsburg.

Lifting Magnets.

Browning Engineering Co., Cleveland.
Elec. Controller & Supply Co., Cleveland.

Light Railways.

C. W. Hunt Co., New York.
Arthur Koppel Co., New York.
Link-Belt Eng'g Co., Phila.
Robins Conveying Belt Co., N. Y.

Lockers.—Metal.

Merritt & Co., Phila.

Locomotive Cranes.

Brown Hoisting Mchy, Co., Cleveland.
Browning Engineering Co., Cleveland.
Industrial Wks., Bay City, Mich.
Interstate Engineering Co., Cleveland.
Mead-Morrison Mfg. Co., Boston.

Locomotives.

American Locomotive Co., New York.
Baldwin Locomotive Wks., Phila.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
C. W. Hunt Co., New York.
Jeffrey Mfg. Co., Columbus.
Arthur Koppel Co., New York.
H. K. Porter Co., Pittsburg.
Robins Conveying Belt Co., N .Y.
Vulcan Iron Works, Wilkes-Barre, Pa.
Westinghouse Elec. & Mfg. Co., Pittsburg.

Lubricants.

Jos. Dixon Crucible Co., Jersey City.
S. Obermayer Co., Cincinnati.

Lubricating & Oiling Devices.

Lunkenheimer Co., Cincinnati.
Wm. Powell Co., Cincinnati.

Lubricators.

Greene, Tweed & Co., New York.
Lunkenheimer Co., Cincinnati.
Wm. Powell Co., Cincinnati.
D. T. Williams Valve Co., Cincinnati.

Machinery Exhibits.

Bourse, Philadelphia.

Machinery, Second Hand.

Niles-Bement-Pond Co., New York.

Machinists' Small Tools.

Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford.
William Sellers Co., Inc., Phila.

Measuring Tapes.

Keuffel & Esser Co., New York.
Kolesch & Co., New York.
Lufkin Rule Co., Saginaw, Mich.

Metal, Expanded.

Associated Expanded Metal Cos., N. Y.

Metal Lath.

Clinton Wire Cloth Co., New York.
Roebling Construction Co., N. Y.

Meters, Electric.

General Electric Co., New York.
Western Electric Co., Chicago.
Westinghouse Elec. & Mfg. Co., Pittsburg.
Weston Elec. Inst. Co., Waverly Park, Newark, N. J.

Milling Machines.

Adams Co., Dubuque, Iowa.
Becker-Brainard Mill. Mch. Co., Hyde Park, Mass.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.

Mill Supplies.

Lunkenheimer Co., Cincinnati.
Robins Conveying Belt Co., N. Y.

Mine Cars.

Allis-Chalmers Co., Milwaukee.
C. W. Hunt Co., New York.
Jeffrey Mfg. Co., Columbus.
Arthur Koppel Co., New York.

Mining Law.

John J. Cushing, New York.

Mining Machinery.

Allis-Chalmers Co., Milwaukee.
Am. Diamond Rock Drill Co., N. Y.
Bradley Pulverizer Co., Boston.
Brown Hoisting Mchy, Co., Cleveland.
Browning Engineering Co., Cleveland.
Fawcus Machine Co., Pittsburg.
Geo. F. Blake Mfg. Co., New York.
Deane Steam Pump Co., New York.
General Electric Co., New York.
Goulds Mfg. Co., Seneca Falls, N. Y.
Ingersoll-Rand Co., New York.
Jeffrey Mfg. Co., Columbus.
Knowles Steam Pump Wks., N. Y.
Arthur Koppel Co., New York.
Laidlaw-Dunn-Gordon Co., New York.
Lambert Hoist. Eng. Co., Newark.
Lidgerwood Mfg. Co., New York.
Marion Steam Shovel Co., Marion, O.
John H. McGowan Co., Cincinnati.
Mead-Morrison Mfg. Co., Boston.
Mecklenburg Iron Wks., Charlotte, N. C.
Norwalk Iron Wks., So Norwalk, Ct.
Platt Iron Works, Dayton, Ohio.
Power Specialty Co., New York.
Providence Eng'g Wks., Providence.
Risdon Iron Works, San Francisco.
Robins Conveying Belt Co., N. Y.
F. L. Smidth & Co., New York.
Snow Steam Pump Wks., New York.
Sullivan Machinery Co., Chicago.
Trenton Iron Wks. Co., Trenton, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg.
Henry R. Worthington, New York.

Motors, Electric.

Allis-Chalmers Co., Milwaukee.
Barriett Elec. Mfg. Co., Cincinnati.
Browning Engineering Co., Cleveland.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Cutler-Hammer Mfg. Co., Milwaukee.
Diehl Mfg. Co., Elizabethport, N. J.
Elec. Controller & Supply Co., Cleveland.
General Electric Co., New York.
Jeffrey Mfg. Co., Columbus.
Lincoln Motor Works Co., Cleveland
Northern Elec. Mfg. Co., Madison.
Stow Mfg. Co., Binghamton, N. Y.
B. F. Sturtevant Co., Hyde Park, Mass.
Western Electric Co., Chicago.
Westinghouse Elec. & Mfg. Co., Pittsburg.

Motors, Steam Turbine.

De La Val Steam Turbine Co., Trenton.

Moulding Machines.

Geo. F. Blake Mfg. Co., New York.
S. Obermayer Co., Cincinnati.
Power Specialty Co., New York.

Name Plates.

Am. Ry. Supply Co., New York.
Murdock-Shaw Co., Boston.
Schwerdtle Stamp Co., Bridgeport.

Naphtha Gas Machines.

Am. Gas Furnace Co., New York.

Office Furniture.

Globe-Wernicke Co., Cincinnati.
Library Bureau, New York.

Oil Burners.

The Petroleum Iron Works Co., Washington, Pa.

Oil Engines.

De La Vergne Machine Co., N. Y.

Oil Refining Plants.

The Petroleum Iron Works Co., Washington, Pa.

Packing.

Boston Belting Co., Boston.
Chaplin-Fulton Mfg. Co., Pittsburgh.
Pennsylvania Rubber Co., Jeanette, Pa
Jenkins Brothers, New York.

Paint Graphite.

S. Obermayer Co., Cincinnati.

Paints and Varnishes.

Jos. Dixon Crucible Co., Jersey City

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Paper-Mill Machinery.

Geo. F. Blake Mfg. Co., New York.
Deane Steam Pump Co., New York.
Goulds Mfg. Co., Seneca Falls, N. Y.
Jeffrey Mfg. Co., Columbus.
Knowles Steam Pump Wks., N. Y.
Laidlaw-Dunn-Gordon Co., New York.
Robins Conveying Belt Co., N. Y.
Snow Steam Pump Wks., New York.
Henry Worthington, New York.

Patent Attorneys.

Gustav Ayres, Washington, D. C.
Eugene C. Brown, Washington, D. C.
C. A. Dieterich, New York.
Evans, Wilkins & Co., Washington, D. C.
O. J. Haegler, Philadelphia.
Luther L. Miller, Chicago.

Pattern-Makers' Machinery.

Fay & Egan Co., Cincinnati.
Pratt & Whitney Co., Hartford.

Pattern Makers.

Buffalo Gear & Pattern Wks., Buffalo.

Penstocks.

Walsh's Holyoke Steam Boiler Co., Holyoke, Mass.

Perforated Metal.

Allis-Chalmers Co., Milwaukee.
H. W. Caldwell & Son Co., Chicago.
Hendrick Mfg. Co., Carbondale, Pa.

Phosphor Bronze.

Lunkenheimer Co., Cincinnati.
Phosphor Bronze Smelt. Co., Phila.
Poole Eng'g & Mch. Co., Baltimore.

Pile Drivers.

Bucyrus Co., So. Milwaukee.
Ingersoll-Rand Co., New York.

Piling, Steel Sheet.

U. S. Steel Piling Co., Chicago.

Pipe.

Am. Spiral Pipe Wks., Chicago.
L. O. Koven & Bro., New York.
Pelton Water Wheel Co., Oakland, Cal.
The Petroleum Iron Works Co., Washington, Pa.
U. S. Cast Iron Pipe & Fdy. Co., Phila.
Walworth Mfg. Co., Boston.
Whitlock Coil Pipe Co., Hartford.

Pipe Bends.

Walworth Mfg. Co., Boston.
Whitlock Coil Pipe Co., Hartford.

Pipe-Cutting and Threading Machines.

Armstrong Mfg. Co., Bridgeport, Conn.
Cox & Sons Co., Bridgeton, N. J.
Curtis & Curtis Co., Bridgeport, Ct.
Niles-Bement-Pond Co., New York.
D. Saunders' Sons, Inc., Yonkers, N. Y.
Stoever Fdy. & Mfg. Co., Myerstown, Pa.
Walworth Mfg. Co., Boston.

Pipe—Spiral Riveted.

Amer. Spiral Pipe Wks., Chicago.

Pipe Fittings, Cast-Iron.

American Spiral Pipe Wks., Chicago.
Pelton Water Wheel Co., San Francisco.
Pittsburg Valve & Fittings Co., Pittsburg.
Walworth Mfg. Co., Boston.

Planers.

American Tool Works Co., Cincinnati.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.

Planing Mill Machinery.

Fay & Egan Co., Cincinnati.

Pneumatic Tools.

Am. Air Compress. Wks., N. Y.
Chicago Pneu. Tool Co., Chicago.
Clayton Air Compress. Wks., N. Y.
Curtis & Co. Mfg. Co., St. Louis.
Dayton Pneumatic Tool Co., Dayton.
Ingersoll-Rand Co., New York.

Pop Safety Valves.

American Steam Gauge & Valve Mfg. Co., Boston.
Ashton Valve Co., Boston.
Consolidated Safety Valve Co., N. Y.
Lunkenheimer Co., Cincinnati.
Star Brass Mfg. Co., Boston.

Portable Drilling Machines.

Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Star Drilling Machine Co., Akron, O.

Powder Mixers.

M. D. Dunning, Syracuse.

Power Hammers.

Williams, White & Co., Moline.

Power Machinery, Steam or Water.

Allis-Chalmers Co., Milwaukee.

Power-Transmission Mchy.

Allis-Chalmers Co., Milwaukee.
Brown Hoisting Mchy, Co., Cleveland.
Browning Engineering Co., Cleveland.
H. W. Caldwell & Son Co., Chicago.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Hayward Co., The, New York.
Jeffrey Mfg. Co., Columbus.
Link-Belt Co., Phila.
Mead-Morrison Mfg. Co., Boston.
Mecklenburg Iron Wks., Charlotte, N. C.
Morse Chain Co., Ithaca, N. Y.
Niles-Bement-Pond Co., New York.
Northern Elec. Mfg. Co., Madison.
Platt Iron Works Co., Dayton.
Robins Conveying Belt Co., N. Y.
Rockwood Mfg. Co., Indianapolis.
Webster Mfg. Co., Chicago.
Western Electric Co., Chicago.
Westinghouse Elec. & Mfg. Co., Pittsburg.
R. D. Wood & Co., Phila.

Presses and Dies.

Curtis & Curtis Co., Bridgeport.
Niagara Mch. & Tool Wks., Buffalo.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.
Watson-Stillman Co., New York.
R. D. Wood & Co., Phila.

Production Engineers.

John A. Cooper, Chicago.
Gunn, Richards & Co., New York.
Library Bureau, New York.
Stephen T. Williams, New York.

Prospecting Drills.

Am. Diamond Rock Drill Co., N. Y.
Ingersoll-Rand Co., New York.
Keystone Traction Drill Co., Beaver Falls, Pa.
Star Drilling Machine Co., Akron, O.
Sullivan Machinery Co., Chicago.

Pulleys, Shafting & Hangers.

Allis-Chalmers Co., Milwaukee.
Am. Tool & Machine Co., Boston.
H. W. Caldwell & Sons Co., Chicago.
Fay & Egan Co., Cincinnati.
Jeffrey Mfg. Co., Columbus.
Poole Eng'g & Mch. Co., Baltimore.
Robins Conveying Belt Co., N. Y.
Rockwood Mfg. Co., Indianapolis.

Pulverizing Mill.

W. D. Dunning, Syracuse.
Lehigh Car, Wheel & Axle Works, Catasauqua, Pa.
F. L. Smidth & Co., New York.
Vulcan Iron Works, Wilkes-Barre, Pa.

Pump Governors.

Albany Steam Trap Co., Albany.
Chaplin-Fulton Mfg. Co., Pittsburg.
Mason Regulator Co., Boston.
Platt & Co., John, New York.
Strong, Carlisle & Hammond Co., Cleveland.
Williams Gauge Co., Pittsburg.

Pumps and Pumping Mchy.

Albany Steam Trap Co., Albany.
Alberger Condenser Co., New York.
Allis-Chalmers Co., Milwaukee.
Ashcroft Mfg. Co., New York.
Geo. F. Blake Mfg. Co., New York.
Bucyrus Co., So. Milwaukee.
Buffalo Forge Co., Buffalo.
Cameron Steam Pump Wks., N. Y.
Clayton Air Compress. Wks., N. Y.
I. B. Davis & Son, Hartford.
Deane Steam Pump Co., New York.
De La Val Steam Turbine Co., Trenton.
Deming Co., The, Salem, Ohio.
Emerson Steam Pump Co., Alexandria, Va.
Epping-Carpenter Co., Pittsburg.
Flint & Walling Mfg. Co., Kendallville, Ind.
Goulds Mfg. Co., Seneca Falls, N. Y.
Guild & Garrison, Brooklyn.
Hall Steam Pump Co., Pitsburg.
Holly Mfg. Co., New York.
Ingersoll-Rand Co., New York.
Knowles Steam Pump Wks., N. Y.
Laidlaw-Dunn-Gordon Co., New York.
Lawrence Mch. Co., Lawrence, Mass.
Lawrence Pump & Engine Co., Lawrence, Mass.
John H. McGowan Co., Cincinnati.
Mecklenburg Iron Wks., Charlotte, N. C.
Morris Mch. Wks., Baldwinsville, N. Y.
Platt Iron Works Co., Dayton.
Platt & Co., John, New York.
Providence Eng'g Wks., Providence.
Snow Steam Pump Wks., New York.
Southwark Fdy. & Mch. Co., Phila.

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E. W. Vanduzen Co., Cincinnati.
Watson-Stillman Co., New York.
Robt. Wetherill & Co., Chester, Pa.
Wheeler Condenser & Eng'g Co., N. Y.
R. D. Wood & Co., Phila.
Henry R. Worthington, New York.

Pumps, Syphon.

Chaplin-Fulton Mfg. Co., Pittsburgh.

Pump Pressure Regulator.

Julian D'Este Co., Boston.
Mason Regulator Co., Boston.

Punching & Shearing Mchy.

Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
Buffalo Forge Co., Buffalo.
Morgan Construction Co., Worcester.
Niagara Mch. & Tool Wks., Buffalo.
Niles-Bement-Pond Co, New York.
Pratt & Whitney Co., Hartford, Conn.
Williams, White & Co., Moline.
R. D. Wood & Co., Phila.

Pyrometers.

Charles Engelhard, New York.
Queen & Co., Philadelphia.
Uehling Instrument Co., Passaic, N. J.

Quarry Machinery.

Brown Hoisting Mchy. Co., Cleveland.
Browning Engineering Co., Cleveland.
S. Flory Mfg. Co., Bangor, Pa.
Ingersoll-Rand Co., New York.
Lambert Hoist. Eng. Co., Newark.
Lidgerwood Mfg. Co., New York.
John H. McGowan Co., Cincinnati.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.
Star Drilling Machine Co., Akron, O.
Sullivan Machinery Co., Chicago.
Trenton Iron Co., Trenton.

Quartz Glass.

Charles Engelhard, New York.

Racks—Machine Cut.

Wm. Ganschow, Chicago.
R. D. Nuttall Co., Pittsburg.

Rail Braces.

Rail Joint Co., New York.

Rail Joints.

Rail Joint Co., New York.

Railway Shop Machinery.

W. F. & J. Barnes Co., Rockford, Ill.
Brown Hoisting Mchy. Co., Cleveland.
Clayton Air Compress. Wks., N. Y.
Fay & Egan Co., Cincinnati.
Laidlaw-Dunn-Gordon Co., New York.
National Machinery Co., Tiffin, Ohio.
Niles-Bement-Pond Co., New York.
Norwalk Iron Wks., So. Norwalk, Ct.
Pratt & Whitney Co., Hartford.
Stow Flexible Shaft Co., Phila.
Stow Mfg. Co., Binghamton, N. Y.
H. B. Underwood & Co., Phila.
Williams, White & Co., Moline.
William Ganschow, Chicago.

Rawhide Gears.

Fawcus Machine Co., Pittsburg.
New Process Raw Hide Co., Syracuse.

Reamers.

Chicago Pneumatic Tool Co., Chicago.
Ingersoll-Rand Co., New York.
Pratt & Whitney Co., Hartford.

Reinforced Concrete Steel.

Associated Expanded Metal Cos., New York.
Ransome Concrete Mchy., New York.
Roebling Construction Co., New York.
Turner Construction Co., New York.

Resistance Banks and Units.

Elec. Controller & Supply Co., Cleveland.

Rheostats.

Simplex Elec. Heat. Co., Cambridge, Mass.

Rheostat Regulator.

Mason Regulator Co., Boston.

Riveting Machines.

Bethlehem Fdy. & Mch. Co., So. Bethlehem, Pa.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
William Sellers Co., Inc., Phila.
R. D. Wood & Co., Phila.

Rock Breakers.

Allis-Chalmers Co., Milwaukee.
Mead-Morrison Mfg. Co., Boston.
Robins Conveying Belt Co., N. Y.

Rolling Lift Bridges.

Cowing Engineering Co., Cleveland.
Fawcus Machine Co., Pittsburg.

Rolling Mill Machinery.

Fawcus Machine Co., Pittsburg.
Morgan Const. Co., Worcester.
Niles-Bement-Pond Co., New York.
Poole Eng. & Mach. Co., Baltimore.
Robt. Wetherill & Co., Chester, Pa.
Robins Conveying Belt Co., N. Y.
W. S. Tyler Co., Cleveland.

Roofing.

Am. Bangor Slate Co., Easton, Pa.
Bangor Excelsior Slate Co., Easton, Pa.
Barber Asphalt Paving Co., Phila.
Barrett Mfg. Co., New York.
Brown Hoisting Mchy. Co., Cleveland.
Genuine Bangor Slate Co., Easton, Pa.
Stowell Mfg. Co., Jersey City.

Roofing Tin.

Am. Sheet & Tin Plate Co., Pittsburg.

Roofing Slate.

Am. Bangor Slate Co., Easton, Pa.
Bangor Excelsior Slate Co., Easton, Pa.
Genuine Bangor Slate Co., Easton, Pa.
Keenan Structural Slate Co., Easton, Pa.

Rope.

American Mfg. Co., New York.

Rope Transmission.

American Mfg. Co., New York.
H. W. Caldwell & Son Co., Chicago.
C. W. Hunt Co., New York.
Jeffery Mfg. Co., Columbus.
Link-Belt Co., Phila.
Providence Eng'g Wks., Providence.

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Boston Belting Co., Boston.
Jenkins Bros., New York.

Sand Mixers and Sifters.

S. Obermayer Co., Cincinnati.

Sash Operating Device.

Lord & Burnham Co., New York.

Saw-Mill Machinery.

Allis-Chalmers Co., Chicago.
Curtis & Co., Mfg. Co., St. Louis.
Fay & Egan, Cincinnati.
Jeffrey Mfg. Co., Columbus.

Saws, Hack.

Niles-Bement-Pond Co., New York.

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Buffalo Scale Co., Buffalo.
Fairbanks Co., New York.
Richardson Scale Co., New York.

Screens, Mining.

Allis-Chalmers Co., Milwaukee.
Jeffrey Mfg. Co., Columbus.

Screens, Rolled Slot.

Allis-Chalmers Co., Milwaukee.
W. S. Tyler Co., Cleveland.

Screw Jacks.

Joyce, Cridland Co., Dayton.

Screws.

Cleveland Cap Screw Co., Cleveland.

Screw Machines.

Jones & Lamson Mch. Co., Springfield, Vt.
National-Acme Mfg. Co., Cleveland.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.

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B. F. Sturtevant Co., Hyde Park, Mass.

Separators, Steam and Oil.

Allis-Chalmers Co., Milwaukee.
American Tool & Mch. Co., Boston.
Austin Separator Co., Syracuse.
John Davis Co., Chicago.
Julian D'Este Co., Boston.
Direct Separator Co., Syracuse.
Goubert Mfg. Co., New York.
Harrison Safety Boiler Wks., Phila.
Hoppes Mfg. Co., Springfield, O.
Ohio Blower Co., Cleveland.
Potter Separator Co., Newburgh, N. Y.
Warren, Webster & Co., Camden N. J.
Watson & McDaniel Co., Phila.

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Elec. Controller & Supply Co., Cleveland.

Shapers.

American Tool Works Co., Cincinnati.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford.

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Shop Lamps, Gas.

General Gas Light Co., Kalamazoo, Mich.

Shutters (Fire).

Kinnear Mfg. Co., Columbus.

Slate.

Am. Bangor Slate Co., Easton, Pa.
Bangor Excelsior Slate Co., Easton, Pa.
Genuine Bangor Slate Co., Easton, Pa.
Keenan Structural Slate Co., Easton, Pa.
Pennsylvania Structural Slate Co. Easton Pa.

Slushing Compound.

Warren Bros. Co., Boston.

Special Machinery.

J. B. Chapman & Co., Springfield, Mass.
Fawcus Machine Co., Pittsburg.

Speed Controllers.

Foster Engineering Co., Newark.

Spiral Gears.

R. D. Nuttall Co, Pittsburg.

Sprinkler Leakage Insurance.

Maryland Casualty Co., Baltimore.

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The Petroleum Iron Works Co., Washington, Pa.

Stamps — Steel, Alphabets and Figures.

Schwerdtle Stamp Co., Bridgeport.

Stand Pipes.

Sam'l Smith & Son Co., Paterson, N. J.
Struthers-Wells Co., Warren, Pa.
The Petroleum Iron Works Co., Washington, Pa.
Tippett & Wood, Phillipsburg, N. J.
Walsh's Boiler Wks., Holyoke, Mass.

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American Steam Gauge & Valve Mfg. Co., Boston.
Star Brass Mfg. Co., Boston.

Steam Jet Pumps.

E. W. Vanduzen Co., Cincinnati.

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Ashcroft Mfg. Co., New York.
Crane Co., Chicago.
Golden-Anderson Valve Specialty Co., Pittsburg.
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Platt & Co., John, New York.
Power Specialty Co., New York.
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Browning Engineering Co., Cleveland.
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Mead-Morrison Mfg. Co., Boston.
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American Ball Co., Providence,
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R. D. Wood & Co., Phila

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Berlin Construction Co., Berlin Conn.
Ransome & Smith Co., N. Y.
Tucker & Vinton, New York
Turner Construction Co., New York.

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Wm. Jessop & Sons New York.

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Curtin-Ruggles Co., New York.
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Bangor Excelsior Slate Co., Easton, Pa.
Genuine Bangor Slate Co., Easton, Pa.
Keenan Structural Slate Co., Easton, Pa.
Pennsylvania Structural Slate Co., Easton, Pa.

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Western Electric Co., Chicago.

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Tippett & Wood, Phillipsburg, N. J.
Walsh's Boiler Wks., Holyoke, Mass.
Robt. Wetherill & Co., Chester, Pa.

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Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford.

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Kolesch & Co., New York.
Keuffel & Esser Co., New York
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Maryland Casualty Co., Baltimore.

Temperature Regulators.

Julian D'Este Co., Boston.

Tenoning Machines.

Fay & Egan Co., Cincinnati.

Thermometers.

Bristol Co., Waterbury.
Hohmann & Maurer Mfg. Co., Rochester.

Time Checks.

Am. Ry. Supply Co., New York.
Schwerdtle Stamp Co., Bridgeport.

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Tin, Roofing.
Am. Sheet & Tin Plate Co., Pittsburg.

Tracing Cloth.
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Kolesch & Co., New York.

Traveling Link Grates.
Green Engineering Co., Chicago.

Trolleys.
Browning Engineering Co., Cleveland.
Maris Bros., Philadelphia.

Trucks, Commercial.
Electric Vehicle Co., Hartford.

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S. Obermayer Co., Cincinnati.

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Allis-Chalmers Co., Milwauke.
De La Val Steam Turbine Co., Trenton.
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Niles-Bement-Pond Co., New York.
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American Typewriter Co., New York.

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G. M. Gest, New York.

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Williams, White & Co., Moline.

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Hohmann & Maurer Mfg. Co., Rochester.

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Geo. F. Blake Mfg. Co., New York.
Clayton Air-Compres. Wks., N. Y
Deane Steam Pump Co., New York.
Goulds Mfg. Co., Seneca Falls, N. Y.
Guild & Garrison, Brooklyn.
Knowles Steam Pump Wks., N. Y.
Laidlaw-Dunn-Gordon Co., New York.
John H. McGowan Co., Cincinnati.
Platt Iron Works, Dayton, Ohio.
Snow Steam Pump Wks., New York.
Wheeler Condenser & Eng'g Co., N.Y.
Henry R. Worthington Co., New York.

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Emerson Steam Pump Co., Alexandria, Va.

Valves, Gas Engine.
Cleveland Cap Screw Co., Cleveland.

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Ashton Valve Co., Boston.
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Walworth Mfg. Co., Boston.
Watson & McDaniel Co., Phila.

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Strong, Carlisle & Hammond Co., Cleveland.
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Troy Wagon Works Co., Troy, Ohio.

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Henry R. Worthington, New York.

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Hydrex Felt & Eng'g Co., New York.

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Platt Iron Works, Dayton.

Water Purifying Apparatus.
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Wm. B. Scaife & Sons Co., Pittsburg.
Warren Webster & Co., Camden, N. J.

Water Softening Apparatus.
Harrison Safety Boiler Wks., Phila.
Wm. B. Scaife & Sons Co., Pittsburg.
Warren Webster & Co., Camden, N.J

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Allis-Chalmers Co., Milwaukee.
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Pelton Water Wheel Co., San Francisco.
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Poole Eng'g & Mch. Co., Baltimore.
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Holly Mfg. Co., New York.
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Laidlaw-Dunn-Gordon Co., New York.
Lawrence Mch. Co., Lawrence, Mass.
Platt Iron Works, Dayton, Ohio.
Snow Steam Pump Wks., New York.
Southwark Fdy. & Mch. Co., Phila.
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Keystone Traction Drill Co., Beaver Falls, Pa.
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Laidlaw-Dunn-Gordon Co., New York.
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Roebling Construction Co., N. Y.

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U. S. Wood Preserving Co., New York.

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Chicago Pneumatic Tool Co., Chicago
Fay & Egan Co., Cincinnati.
Ingersoll-Rand Co., New York.

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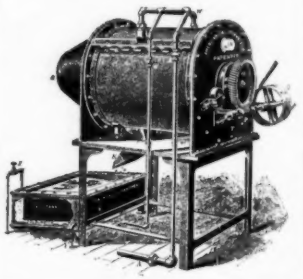

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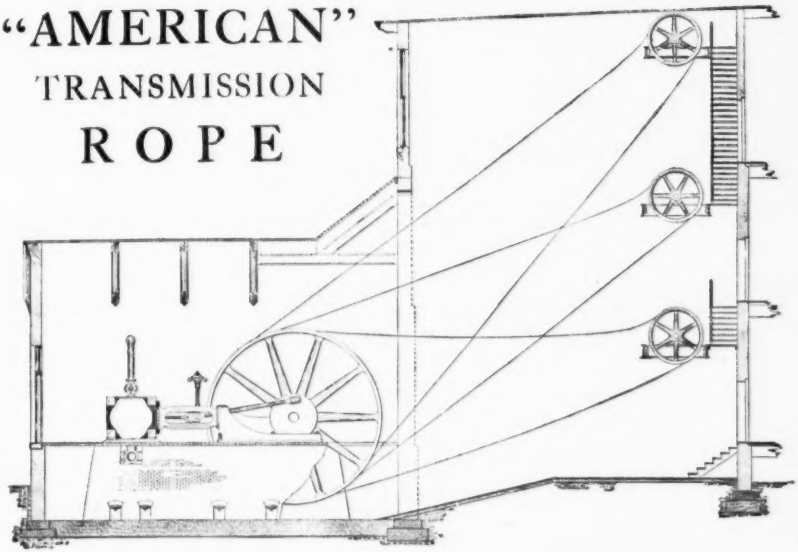

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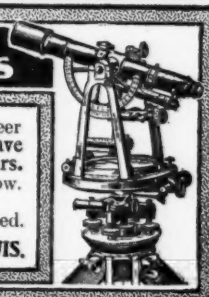

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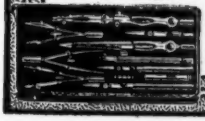

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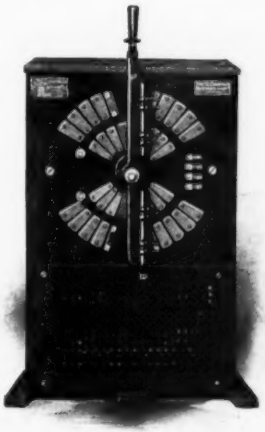
The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

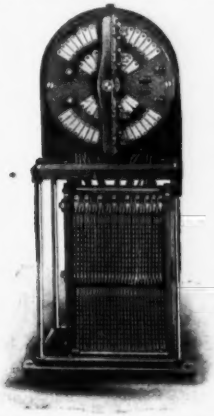
A New Line of Controllers.

THE Electric Controller & Supply Co., of Cleveland, Ohio, are placing upon the market a new line of controllers termed Type G which have a rating of 1 to 50 H. P. These controllers were built to meet the requirements of general crane service where the conditions are not severe enough to demand the use of the Dinkey ventilated controller. The Type G-3 and G-4 controllers are built with coil resistance and the Type G-5 and G-6 controllers are built with cast grid resistance. When it is desired to place controllers above or in the



TYPE G-5 CONTROLLER, FRONT VIEW.

rear of the operator the Type G controller is furnished arranged for under lever operation. They are also furnished with spring return for operation from the floor by means of pendent ropes or chains. A number of crane users have decided that a 15 or 20 ton crane requiring a 25 or 30 horse-power motor on the hoist and bridge motion may be operated from the floor by any of the men in the shop, thus saving the wages of a crane operator who would probably be idle half his time. It is a very simple matter to put cutouts at either end of the trolley travel and at either end of the runway to prevent accident. The Type G controller meets this demand for a controller up to 50 horse-power arranged for operation from the floor by means of ropes. This controller is a self-contained unit, the resistance being placed in the frame, making it necessary to run only four wires between the controller and motor. Reversal is accomplished by the use of a single lever, no separate reverse switch being required. The Type G controllers are self-contained, compact, and accessible. All parts are made to jig and are interchangeable. The contact face is of heavy slate, free from metallic veins. The contact segments are of copper which are screwed to brass lugs to which all wiring connections are made. By this construction any of the contact segments can be removed and replaced without disturbing the wiring connections. The contact



TYPE G-6 CONTROLLER, FRONT VIEW, ALL CASES REMOVED SHOWING RESISTANCE AND FACE OF CONTROLLER.

arms is of soft cast iron and carries the fingers and finger holders, the insulation of

which is of heavy pressed vulcabuston bushings. The contact fingers are of dropped forge copper of great hardness and may be removed and replaced without removing the contact arm. A powerful and effective blow-out is provided in all sizes of these controllers. The frame for Type G-3 and G-5 controllers consists of a main casting in one piece provided with a cover, the removal of which affords easy access to all resistance connections. The case enclosing this frame is of perforated steel, thus allowing ample ventilation. The frame of the G-4 and G-6 controllers consists of a bottom casting which supports the resistance, and a top casting which supports the contact slate and arm. The top and bottom casting are connecting by means of four steel corner posts around which a casing of perforated steel is provided for ventilation and protection to resistance. The top casting of the G-4 and G-6 controllers supports the contact slate which is completely covered and protected by a sheet steel casing. This protects the operator from coming in contact with any live parts of the controller, and also protects the working parts of the controller from dust and dirt. Easy operation is secured by a lever which is keyed to the arm shaft at the back of the top casting, which gives a short movement of about 10 inches in either direction for both starting and reversing. The resistance for the G-5 controller is built of cast grids in a single bank which may easily be removed as a unit without disturbing the other parts or moving the controller. The resistance for the G-6 controller is made of two banks supported on bars attached to the frame, and may be removed in separate units without disturbing the other parts. The resistance for Type G-3 and G-4 controllers is made up of Type E coils which consist of a heavy asbestos tube stiffened by means of a central brass tube which serves to bring the rear terminal forward, facilitating the necessary connections. These controllers are very adaptable for service up to 500 volts. Six points of control are provided with the G-3 and G-5 controllers, and eight points of control with the G-4 and G-6 controllers.

The Cone Gas Generator.

THE Cone gas generator, using bituminous coal, and now manufactured for the United States by the Cone Gas Machine Co., Detroit, occupies a field entirely its own by its revolutionary improvements in the generation of gas. Until this machine was demonstrated it has been considered impossible to use bituminous coal in a gas generator without the formation of tar, requiring the addition of expensive auxiliary machinery to remove or burn it, which made it impractical in most power plants. The Cone vacuum process entirely removes this difficulty, and not only does not form tar, but preserves in a fixed gas the ethylene and methane series (the highest heating gases yielded by the coal) which in all other soft coal producers are destroyed by destructive distillation. The process employed in the Cone generator is an entirely new departure in gas making, and really combines in one the three known methods of securing gas from coal, viz., (1) distillation by which the volatile hydro-carbons are driven off as in illuminating gas; (2) the water gas process in which the elements of water H_2 and O are dissociated in the presence of incandescent carbon, the element O uniting with carbon to form CO and the element H being set free; (3) the air gas process by which the O of the air forced through the incandescent fuel unites with the free carbon to form CO or carbon monoxide, the well known fuel gas,—thus utilizing all the available heat obtainable from the coal, and leaving nothing but ash as a waste.

This seemingly complicated process is, however, simplicity itself in its application and when understood. Its method may be explained as follows: The fuel is divided into two zones called the primary or lower zone and the secondary or upper zone. The coal is introduced at the top and passes through the different processes of distillation, until by the time it reaches the primary zone it is coke. The coke in this zone is exposed to air only, admitted through the rose in the center, and keeps this part of the fuel at incandescent heat continually whether the generator is run-

ning on full load or on no load. The vaporizer located between the primary and secondary zones, supplies large quantities of steam at this point and thereby retards combusion of the coal above, sufficiently to prohibit destructive distillation of the higher volatiles which pass off in a fixed gas. The union of the elements to form tar is prevented as follows: (1) by the excessive amount of steam introduced and (2) by coming in contact with the cooler surface of the air and water heaters shown surrounding the reservoir at the top of the generator. The result of this process briefly stated is: (1) that it is entirely automatic, requiring no attention but to feed the coal and remove the ashes; (2) it gives a perfectly tarless gas of high calorific value; *(3) while the fuel is passing through the different stages of distillation the heat is too low to make clinker, but when the coke reaches the primary zone it is too well digested to form anything but small clinker which passes out freely with the ashes; (4) the machine will always respond instantly from no load to full load, as a high heat is always maintained in the primary zone and increases the output of gas the moment the suction is increased; (5) it yields a gas from cheap bituminous coal or lignite, greatly exceeding in heat value the gas obtained from the more expensive anthracite.

Many well known gas engineers have made exhaustive tests of this machine and are enthusiastic in its praise; space prevents the insertion of these tests, but they can be obtained by addressing Cone Gas Machine Co., Detroit, Mich.

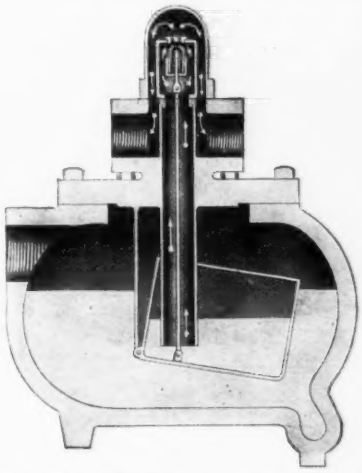
*Gas made in the Cone producer from Pocahontas coal, tested by means of the Junker calorimeter showed it to have a heating value of 233.5 B. T. U. per cubic foot at 0° and 760 m-m barometer pressure. It had the following composition:

CO_2	C_2H_4	O_2	CO	H_2	CH_4	N_2
5.0	2.0	1.0	12.8	18.1	8.4	52.7

Testing a Steam Trap at High Pressure.

THE accompanying photograph shows a new Squires steam trap operating at 375 pounds pressure in a test made by its inventors, C. E. Squires and Benjamin Silliman of Cleveland, Ohio. The trap has just discharged, throwing out 241 cubic inches of water in less than one second. The impression that steam is escaping with the water is erroneous. Steam does escape from some traps, but usually as a result of wire-drawing between the periods of water discharges. The appearance of steam in the photograph is due to the fact that vapor "takes" in a photograph as steam and that part of the water discharged at high temperature and pressure flashes into steam instantly on being liberated. In this instance very little moisture came down, all having been converted into vapor before there was time to reach the ground.

The unusual method of supplying steam used in testing these traps was adopted because there were no high pressure boilers available, the Cleveland Electric Illuminating Company with a maximum of 165 pounds offering the next highest steam pressure in the city. The automobiles are

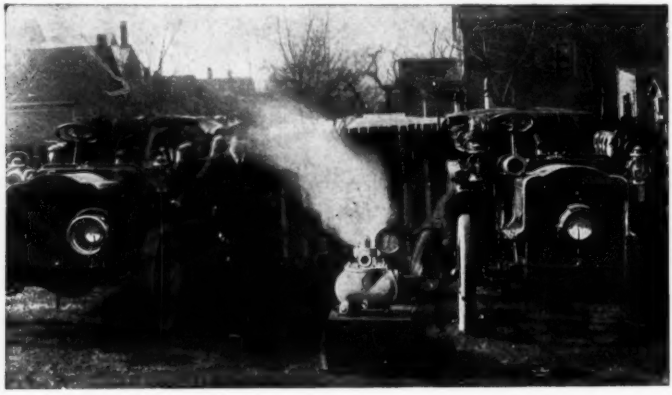


1906 model White steamers equipped with feed water heaters. Their running pressure varies from about 150 to 450 pounds at the steam chest of the engines. The boiler pressures are much higher, the safety valve usually being set between 1,000 and 1,200 pounds. In these tests the safety valves were set for 750 pounds.

After subjecting the trap to 1,000 pounds per square inch hydrostatic pressure at the factory, it was connected to the automobile as shown, so that steam at various pressures entered from the boiler of the machine on the right, and heated water at similar pressures entered from the feed

pump of the one on the left. Water could then be turned into the trap in any quantity, taking the place of condensation in ordinary service.

Steam alone was admitted to the trap at first until the gauge indicated 600 pounds, the pressure which was maintained for some time to test the gaskets. These are vital parts in high pressure work, as they must be unaffected by the moisture of saturated and the heat of superheated steam, and as the joints must come apart easily for inspection of the trap interior. In this test the joints remained perfectly tight. The packing used was a special corrugated copper gasket, which, in addition to meeting the requirements mentioned, does not deteriorate if the joint is taken apart often. A feature of the trap tested adapting it to high pressure work is the placing of the joints entirely above the water line. Traps having the main joint partly in contact with steam and partly with water will do on medium pressures, but, owing to the widely varying temperature of the contained water and steam at high pressure, begin to leak from the effect of unequal expansion. A second test was made to find the highest pressure at which the trap would operate.



The following short description, in connection with the cross-sectional view of the trap will enable the reader to understand the manner in which the trap works. Its action depends upon the buoyancy of a cast iron bucket hinged on cone bearings at one side and connected to the valve mechanism by a similarly hinged brass rod. The proportions of the bucket and the location of the valve rod are such that at atmospheric pressure the bucket when submerged exerts a pull of six pounds on the valve rod. In practice when condensation has reached the high water line the bucket fills, sinks and opens an auxiliary valve which is ⅛ inch in diameter. Pressure under the main valve is thus relieved and it is pushed down and open instantly by the internal trap pressure upon its upper surfaces. The bucketful of water is then discharged, and the bucket on rising closes both valves until the operation is repeated. No wire-drawing is possible, as the valves are always wide open or closed tightly.

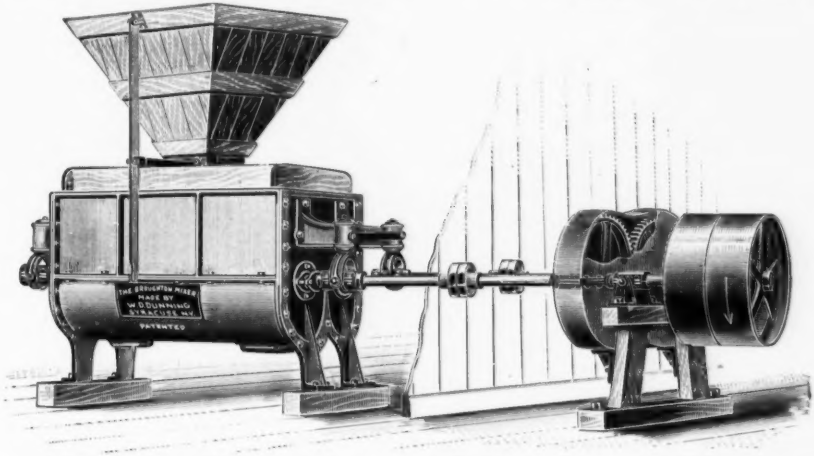
To keep the auxiliary valve (⅛ inch in diameter or .01227 sq. inch in area) shut against the pressure of 6 pounds pull on the stem from the bucket the steam must exert a pressure in pounds per square inch of 6 x 1/.91227 or about 490. These figures neglect the variation in density of water at high temperatures and conditions of motion within the trap. To prove these figures, enough water was pumped into the trap to cover the bucket, and by opening the air vent, the pressure was gradually lowered until the trap began to discharge. This did not occur until the gauge showed 375 pounds, a result which emphasizes the importance of service tests on steam apparatus when reliable data are required.

Additional water was continually pumped in and discharged at this pressure for ten minutes. The action of the valve was accompanied by slight vibration. The discharge sounded like the exhaust of a two-ton steam hammer and could be heard some distance. The pressure was further reduced to 300 pounds, and water pumped into the trap in a continuous stream. The valve action was smooth, and the trap proved itself capable of maintaining perfect operation for an indefinite period.

These tests should interest those who use steam at high temperatures and pressures, and high-pressure plants are increasing yearly. The Squires trap is made by Strong, Carlisle & Hammond Co., of Cleveland, Ohio.

The Broughton Mixer.

THE Broughton mixer, as shown by the accompanying cut, has been used successfully for mixing gun powder for a number of years. The same mixing qualities which have made it a favorite with the largest wall plaster manufacturers in the United States and Canada for the past fifteen years assert themselves equally well in mixing gun powder. The essential point in getting a perfect mixture is to have a mixer that will mix together light and heavy materials evenly, as when one material is heavy and the rest light the tendency in most mixtures is for the heavy to work to the bottom and the light to come to the top.



The Broughton mixer has two shafts running side by side through the mixing chamber which is circling at the bottom, and the mixing paddles are secured to the shafts at an angle in such a manner that, as the shafts rotate in opposite directions, the paddles on their upward movement towards the center of the mixing chamber lift the different materials from the bottom of the case. In so doing one set of paddles casts the materials toward one end of the case while the other set casts it in the opposite direction. This reverse action causes the various ingredients, whether light or heavy, to become thoroughly and uniformly mixed.

All parts of this mixer which come in contact with the powder are made of either brass or aluminium, to guard against explosion.

The American Typewriter.

THE American typewriter provides a medium priced business-like machine, of the type-bar style, with all the advantages of the regular type-bar machine, and the added advantage of a saving of about 1,200 small parts in the finished machine. This great saving in parts is accomplished by forging the key and the type on a single bar of steel—the key at one end and the type at the other. The

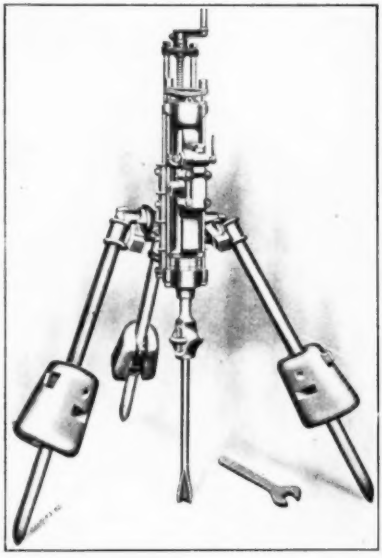
type bar, therefore, is only a simple lever, entirely free from complicated mechanism, and actually cannot get out of order. The weakness of the type bar action of typewriters is in the looseness which soon comes from the wearing of their joints. Some typewriters have as many as sixteen bearings between the key and the type, and some one of these is bound to work loose, spoil alignment and finally break down.

Of equal importance are the ball and socket bearings on which the type bars swing. This simple bearing insures freedom of action and minimum friction, and, consequently, light touch and high speed. The carriage and wheel escapement are mounted on ball bearings—the most approved aids to speed in typewriter construction.

The machine possesses the advantage of the insertion of special characters, such as fractions, accents, special marks, etc., in half a minute's time and changeability of carriage when that may be required. This typewriter possesses a number of other novel and exclusive features described in full in a pamphlet entitled "The American Way." The American Typewriter Co., 268½ Broadway, New York, will send it on request.

The Chicago Giant Rock Drill.

THE designing of a successful machine rock drill is an alluring proposition, calling for an intimate and practical knowledge of the conditions and ruggedness of service in which it has to operate and perform successful work. As it stands to-day, the machine rock drill represents an evolution of features of improvement, made necessary by a long line of demonstrations and failures in actual service. In the design and development of the machine shown in the accompanying illustration, the Chicago Giant Rock Drill, full advantage has been taken of the opportunities presented by embodying such features as have proved their fitness in successful service and combining them with improved features. Every detail has been given careful consideration as to its desirability, suitability of material and weight. Some of the improved features are—the shell which is of the adjustable type, constructed so as to provide for double side bearing for the cylinder; and the shell caps are so made that they will take up wear in two directions, horizontal and vertical, with one adjustment. A removal cylinder stop is also provided in the lower end of the shell. Its function is to prevent the cylinder from slipping out of the shell in case the feed screw should be run out of the feed nut. On the other hand, should it be desired to remove the cylinder from the shell, all that is necessary is to remove the stop first, then by turning the feed screw run the cylinder down in the shell until the feed screw is out of the feed nut; this



will allow the cylinder to be slipped out of the shell without any dismantling of the machine.

The cylinder is cast from a special mixture, having a tensile strength of 35,000 to 38,000 pounds and presenting a fine polished surface when finished. The upper end of the cylinder is extended to form a chamber for the rotating mechanism which is of the releasing type. Three parts are used, thus equally distributing the rotating effect and the pawls are constructed so that they are reversible; *i. e.*, should one of the engaging edges wear out, the pawl can be reversed so as to present the other and un-

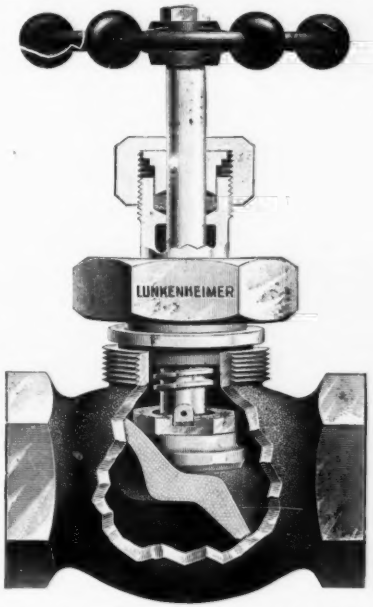
worn edge to engage with the ratchet. This is an important point, as it makes provision for doubling the life of each pawl. The ratchet is of one piece with the rotating or rifle bar, which is extended on its upper end to fit into a chamber or recess into the upper head; this provides for the holding of the rotating bar in a central position and relieves the rotating mechanism of all side strains. The valve motion is positive and is of the tappet or rocker type, modified to give a short stroke feature, the length of the stroke being at all times completely under control of the operator. The supporting pin of the rocker works in renewable steel bushings and is completely enclosed, it being kept in place by caps easily removable but which are securely locked in place by the valve seat when machine is assembled.

One of the most valuable features of the drill is the provision for automatic lubrication. An oil reservoir chamber is provided in the valve seat and communication is made between the oil reservoir and the interior of the valve chest. The oil is led through this channel into the chest where it mixes with the operating fluid and is carried by it into the interior of the machine. One filling of the oil reservoir will last half a "shift." In case the rotating mechanism should not receive sufficient lubrication from the interior, provision is made in the upper head whereby it may be oiled when necessary. Manufactured by the Chicago Pneumatic Tool Co., Chicago, Ill., who will send fuller details on request. The workmanship is of the best and absolute interchangeability of parts is assured.

Improved Regrinding Valves.

THE Lunkenheimer Co., Cincinnati, have made a number of desirable improvements on their regrinding valves. The changes, however, are not at all radical, as the valve has been in use for half a century and has proven itself to be of the correct design, having given general satisfaction wherever used. Its manufacturers, however, increased the weight of the valve, not because the thickness of shell, etc., were too light in their former products, but merely as an additional precaution against rough handling while attaching, etc. The medium pattern valves are guaranteed to stand a working pressure of 200 pounds per square inch and the extra heavy pattern up to 350 pounds per square inch. They have also altered the shape of the valve, which not only makes an elegant appearance but also increases the area through the valve, permitting an unobstructed passage through it, the area being more than equal to that of the connecting pipe.

To insure a perfect and strong joint between the pipe and valve, the pipe threads have been made considerably longer, thereby overcoming the danger of stripping threads which so often happens owing to rough and unskilled workmanship in attaching. All sizes of the valves now have



lock-nuts on the hand wheels, which facilitates the taking apart and assembling of the valve for repairs, etc. Referring to the sectional illustration, it will be noticed that the hub which carries the operating stem is secured to the body by a union connection which, in turn, screws over the shell of the valve body. By means of this construction it is impossible for the hub and the body to become corroded together, as

the thread which holds the union ring to the body is protected at all times from the action of the steam, the joint being made between the flange on the hub and the neck of the body. This connection also acts as a tie or binder in screwing over the body and tends to make the valve rigid and strong. The disc A is held loosely to the stem F by means of the lock-nut J, and therefore will adjust itself to the seat very readily and a tight joint can be relied upon. The stem F is fitted with a very strong, durable and long thread and the hand wheel is of ample diameter to insure the easy operation of the valve.

To regrind the valve, the bonnet ring is unscrewed and the trimmings are removed from the body. A wire or nail is placed through the lock-nut and stem, a little powdered sand or glass and soap or oil is placed on the disc and the trimmings are again placed in the valve and reground. The bonnet has a small rim or projection on the bottom thereof which acts as a guide on the inside of the valve neck while regrinding. The seats in the valve-bodies are very small when the valves are sent out from the factory, which permits of considerable regrinding and is considered an important feature.

The valve can be packed under pressure when open or closed and to pack while the steam is flowing through the valve, open it as wide as possible, when the shoulder at the top of the stem thread will form a seat beneath the stuffing box.

The material used is of the highest grade of bronze composition and the workmanship is in every respect commendable. Before being sent out, every valve is thoroughly tested and inspected, the stuffing boxes are packed and they are ready for immediate use.

The company have, in connection with their plant, a complete physical and chemical laboratory, which enables them to manufacture their products of such composition as are best adapted to withstand the chemical actions, strains, etc., to which the various products are subjected.

Gas Engine Designers.

ILLMER & CO., Fourth National Bank Building, Cincinnati, Ohio, have opened an office as gas engine experts, specializing in gas and oil engine design. By centralizing the design work they are not only enabled to deliver high class design at the least cost because of the saving effected in preliminary work, but at the same time the builder gets the benefit of highly specialized experience and is assured of the very best proportions of parts throughout.

NEWS SUPPLEMENT

The Engineering Magazine—March, 1907

Personal.

—Dodge & Day, Philadelphia, announce that John E. Zimmermann, formerly secretary of the American Pulley Co., has become a partner in their firm.

—American Steam Gauge & Valve Mfg. Co., Boston, advise that R. M. Turner, formerly their eastern representative, has been appointed manager of their publicity department and that C. H. Mosher has been secured to succeed Mr. Turner as eastern representative.

—Arthur Tomalin, formerly news editor of the Newark *Evening News*, has been appointed general advertising manager of the Central Railroad of New Jersey and editor of its monthly magazine "The Suburbanite," with offices at 143 Liberty Street, New York.

—Henry Clark Sergeant of the Ingersoll-Sergeant Drill Co., now an integral part of the Ingersoll-Rand Co., died at his home, Westfield, N. J., recently. Mr. Sergeant was a highly successful inventor, especially in the line of rock drills, air compressors and mining and excavating machinery in general.

Industrial Notes.

—Link-Belt Co., Philadelphia, have opened branch offices at 321 Ellicott Square Bldg., Buffalo, and 440 New York Block, Seattle.

—The Berlin Construction Co., Berlin, Conn., has received a contract for building an extension to the fan shop of the Green Fuel Economizer Co., Matteawan, N. Y.

—The B. F. Sturtevant Co., Boston, is installing for the Textile Machine Works, Reading, a complete emery dust exhausting arrangement consisting of steel plate exhaust fan and dust collector.

—The Century Cement Machine Co., Rochester, has just shipped six Hercules cement block machines to one contractor in Cairo, Egypt, for use in making concrete blocks for public building.

—The Curtis & Curtis Co., Bridgeport, manufacturers of Forbes patent die stocks, are compelled to enlarge their plant, and, in the early spring, will make a large addition to the machine shop, increasing their floor space by something over six thousand square feet, enabling them to about double the number of machines now employed in the manufacture of their pipe cutting and threading machines.

—The B. F. Sturtevant Co., Boston, has recently received orders for its high pressure rotary blowers from the General Fire Extinguisher Co., Atlanta.; Rivett Lathe Co., Brighton, Mass.; Wayne Agricultural Works, Goldsboro, N. C.; J. B. Clark Mfg. Co., Rockford, Ill.; N. Y. Continental Jewel Filtration Co., New York; Winchester Repeating Arms Co., New Haven; Salem Glass Co., Salem, N. J.; and Eastern Chemical Co., Boston.

—The natural draft system of cement burning, which uses very high stacks in order to get the draft, is being superseded by the compressed air apparatus made under the Hurry & Seaman patents, at the plants of the Leheigh Portland Cement Co. The natural draft system was the invention of Mr. Matcham, until lately the general manager of the company. President Trexler, of the Lehigh Company, states that, owing to the facts that the results obtained by the natural draft system did not show the anticipated savings, the Hurry & Seaman device was adopted.

—Buffalo Forge Co., Buffalo, have recently closed a contract with the West Virginia Pulp & Paper Co., Piedmont, Va. The equipment included fan, heater, ducts, rolling shutters, and Buffalo air washer, the latter to be constructed entirely of copper and is used to condense the moisture from the air as it is recirculated through fan, heater, and kiln. In order to condense the

moisture it is only necessary to cool the air from 140° to 100° at which temperature it contains so many more heat units than fresh outside air that a great economy is effected by recirculating the air through the kiln again rather than discharging it from vents and supplying outside air to the fan and heater.

—The Crocker-Wheeler Co., Ampere, N. J., has secured the following orders: Bridgeport Malleable Iron Co., Bridgeport, 1-200 kw direct current generator, 250 v. 208 rpm. 1-90 kw 250 v. 208 rpm direct current generator. Pittsburg & Baltimore Coal Co., Wendel, Pa., 1-300 kw direct current generator 575 v. 150 rpm. W. & J. Knox Net & Twine Co., Baltimore, 25-25 hp dc motors 230 volt 750 rpm. Bridgeton Electric Co., Bridgeton, Conn., 1-500 kw dc generator 550 v. 120 rpm. Alliance Machine Co., Alliance O., 74 motors ranging from 6 to 100 hp all of 220 volts. Bosches Troy Laundry, Austin, Tex., 14 motors ranging from ⅛ to 7½ hp 115 v. and 1-35 kw generator 125 v.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Belting.

DIAMOND RUBBER CO., Akron.—Catalogue illustrating and describing rubber belting. 5 by 7 in.; pp. 128.

Blacksmith Tools.

BUFFALO FORGE CO., Buffalo.—Catalogue 77 illustrating and describing, in addition to the regular line of tools, several new machines as well as changes and improvements in older designs. 3 by 6 in.; pp. 40.

Blowers.

EXETER MACHINE WORKS, Exeter, N. H.—Illustrated catalogue describing blowers, exhaust fans, ventilating wheels, and hot blast heating apparatus. 6¾ by 9 in.; pp. 32.

Boilers.

OIL WELL SUPPLY CO., Oswego, N. Y.—Well-printed catalogue illustrating and describing water tube boilers, together with several tables containing much valuable data. 9 by 6 in.; pp. 30.

Cement.

PENINSULAR PORTLAND CEMENT CO., Jackson, Mich.—Souvenir on the history, development and future of Portland cement. The pamphlet is well printed and handsomely illustrated. 8 by 11 in.; pp. 62.

ALMA CEMENT CO., Wellston, O.—Well-printed book showing their plants and also contains many views of structures on which this cement has been employed. 11 by 7 in.; pp. 100.

Cement Roofing.

PHILIP CAREY MFG. CO., Cincinnati.—Well-printed catalogue devoted to an illustrated description of flexible cement roofing. 6 by 9 in.; pp. 32.

Circuit Breakers.

CUTLER ELECTRICAL & MFG. CO., Philadelphia.—Cloth bound catalogue illustrating and describing circuit breakers. 8 by 11 in.; pp. 196.

Clutches.

AKRON CLUTCH CO., Akron.—Pamphlet containing an illustrated description of friction clutches. 6 by 9 in.; pp. 12.

Concrete Dams.

AMBURSEN HYDRAULIC CONSTRUCTION CO., Boston.—Catalogue illustrating and describing concrete-steel gravity dams. 7½ by 10½ in.; pp. 20.

Core Drills.

INGERSOLL-RAND CO., New York.—Catalogue No. 91 illustrates and describes Davis Calyx diamondless core drills. 6 by 9 in.; pp. 62.

Corrugated Sheathing.

WENDELL & MAC DUFFIE, New York.—Catalogue No. 16 illustrates and describes asbestos and cement fireproofing materials, including reinforced asbestos corrugated sheathing. 4 by 9 in.; pp. 24.

Crucibles.

R. B. SEIDEL, INC., Philadelphia.—Folder illustrating and describing black lead crucibles for melting steel, brass, bronze, gold, silver and other metals. 3½ by 6½ in.; pp. 4.

Cutter and Tool Grinder.

DAYTON MACHINE AND TOOL WORKS, Dayton.—Illustrated catalogue describing the operations of the universal cutter and tool grinder. 6 by 9 in.; pp. 14.

Drill Chucks.

JACOBS MFG. CO., Hartford.—Illustrated catalogue describing drill chucks. 9 by 6 in.; pp. 12.

PRATT CHUCK CO., Frankfort, N. Y.—Booklet illustrating and describing driving drill chucks, together with dimensions and prices. 3½ by 6 in.; pp. 18.

Electric Cranes.

CASE MFG. CO., Columbus.—Bullletin containing an illustrated description of electric cranes. 12 by 9 in.; pp. 32.

Electric Hoists.

SPRAGUE ELECTRIC CO., New York—Pamphlet illustrating and describing hoists and cranes. 4 by 8 in.; pp. 12.

Electric Tools.

CHICAGO PNEUMATIC TOOL CO., Chicago.—Illustrated catalogue describing electric drills, grinders, drilling stands, magnetic man-hoists, etc. 6 by 9 in.; pp. 60.

Emery Wheels.

HAMPDEN CORUNDUM WHEEL CO., Brightwood, Mass.—Catalogue and price list of emery wheels, corundum wheels and machinery. 4 by 7 in.; pp. 48.

Engineering Instruments.

YOUNG & SONS, Philadelphia.—Catalogue and price list illustrating and describing engineering and surveying instruments. 6 by 9 in.; pp. 140.

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EUREKA FIRE HOSE CO., New York.—Folder devoted to an illustrated description of fire hose.

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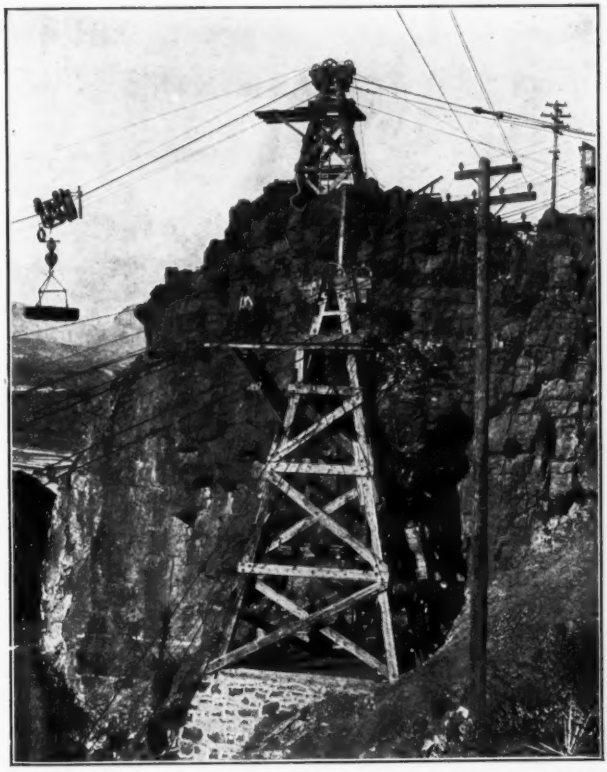

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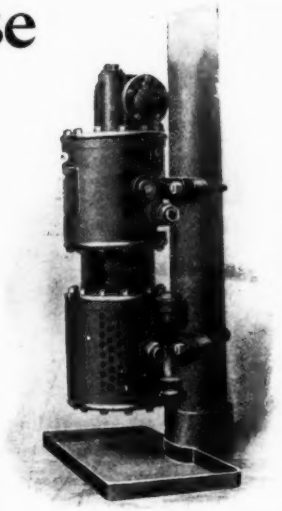

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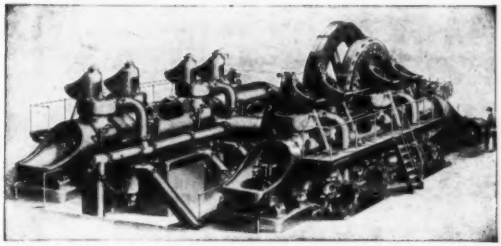

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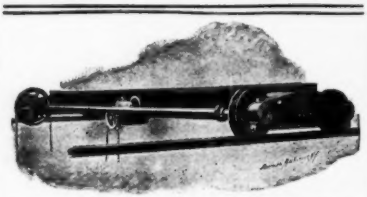

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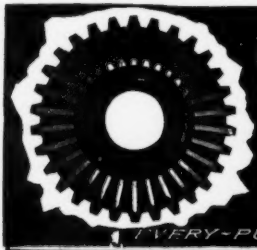

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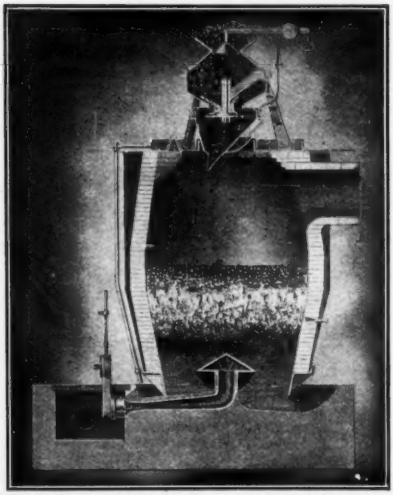

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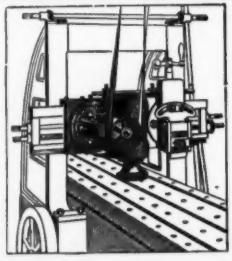

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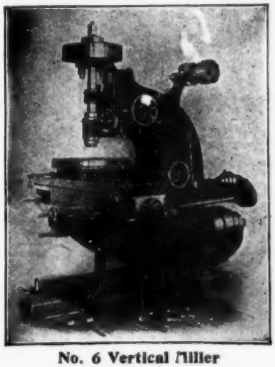

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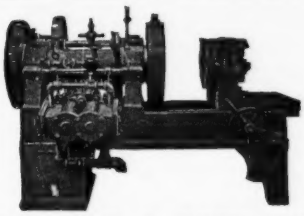

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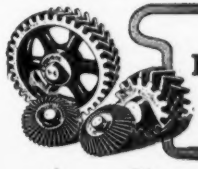

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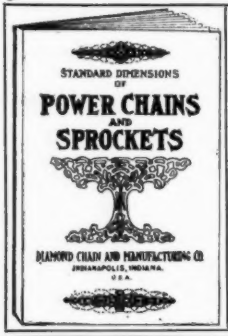

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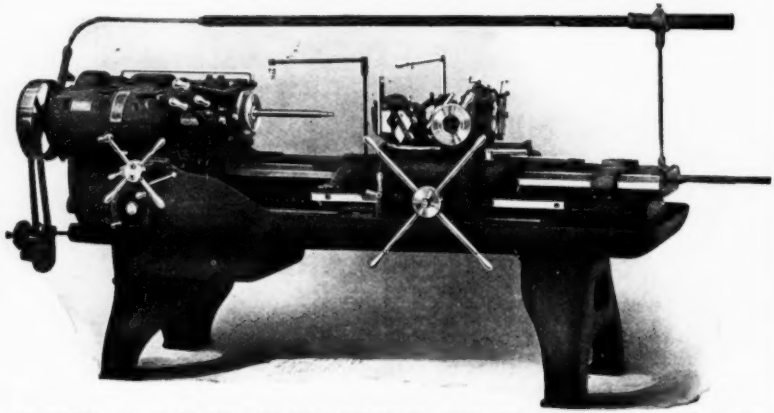

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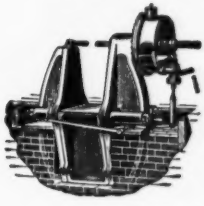

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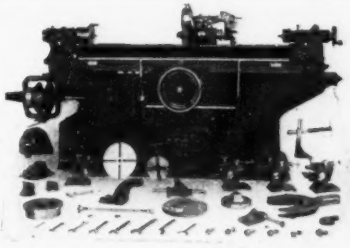

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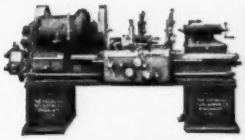

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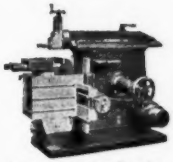

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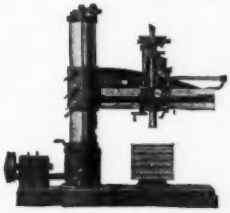

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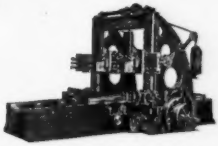

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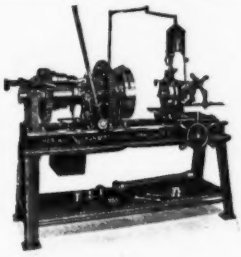

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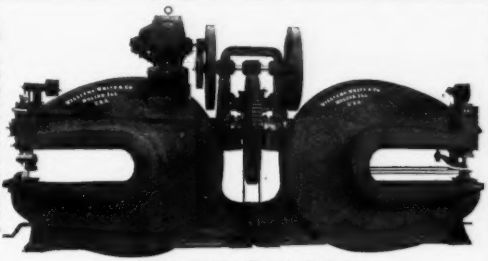

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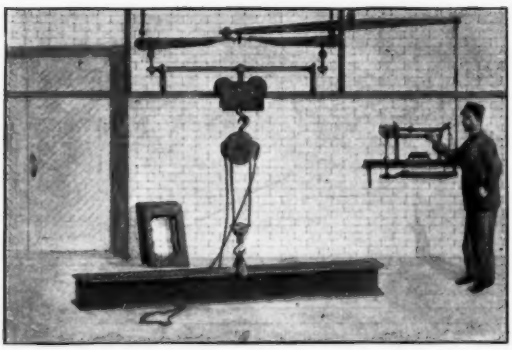

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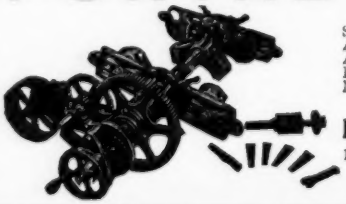

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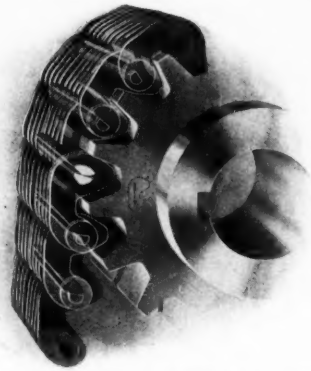

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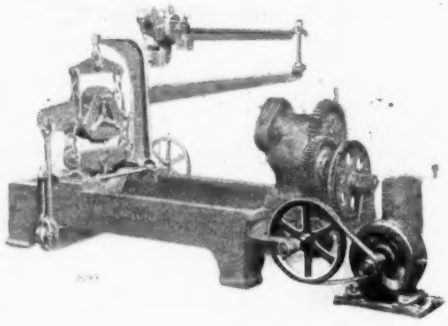

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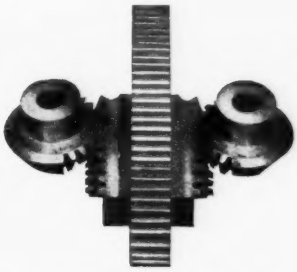

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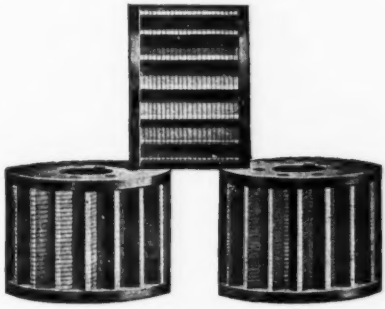

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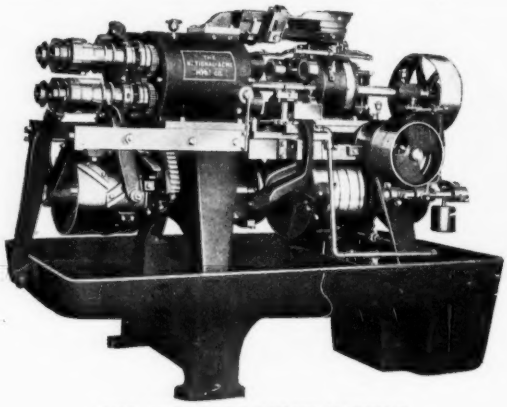

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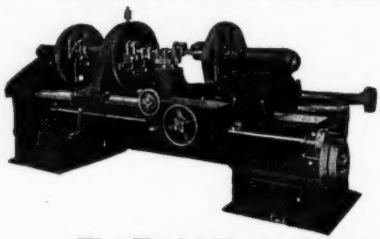

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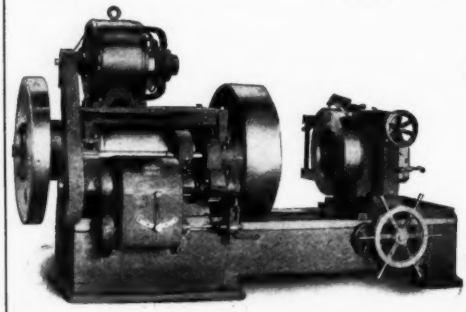

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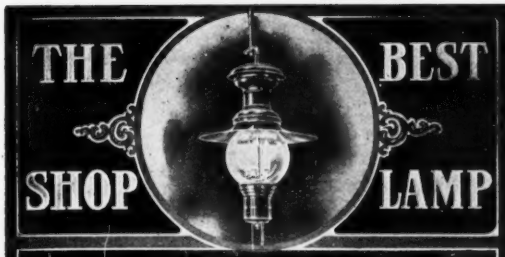

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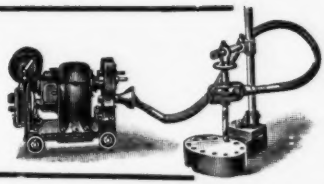

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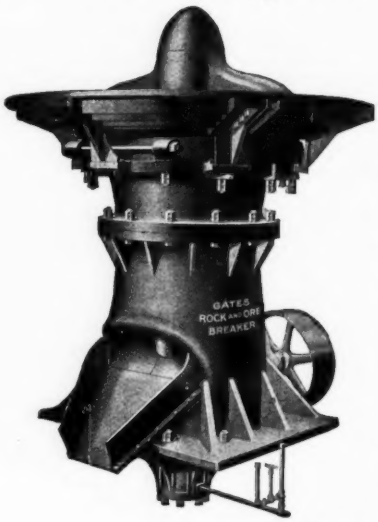

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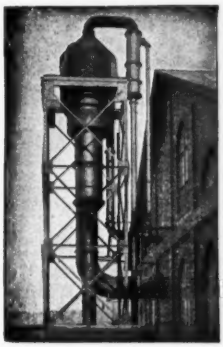

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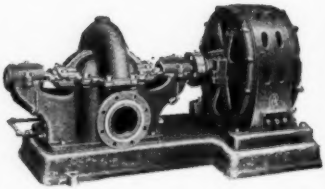

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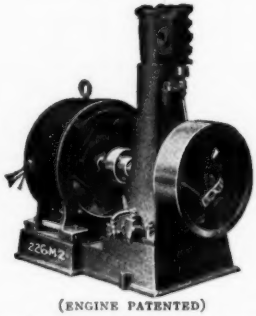

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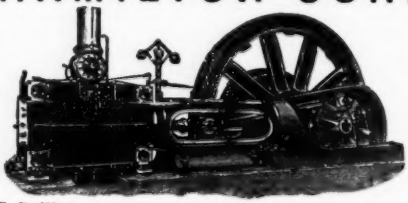

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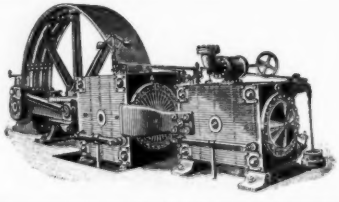

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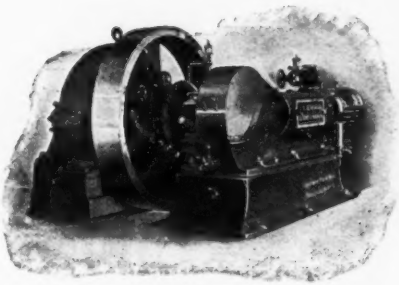

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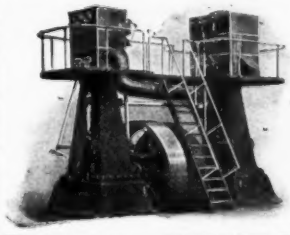

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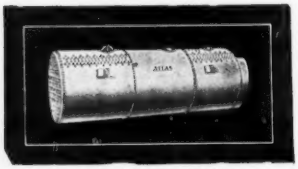

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Engines in Service.
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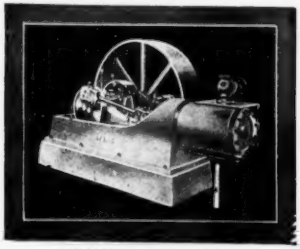

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125 H. P.,	2	150 H. P.,	5	175 H. P.,	4
250 H. P.,	1	300 H. P.,	3	350 H. P.,	4
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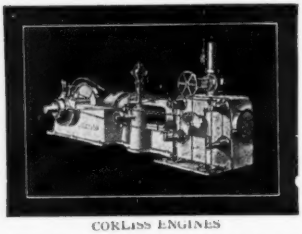

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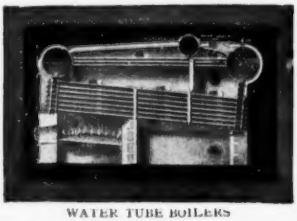

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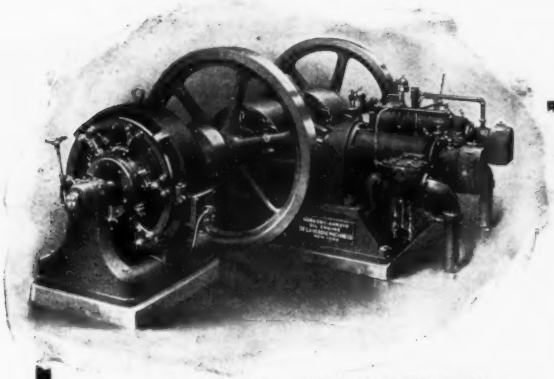

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A guaranteed fuel consumption of less than 1 pound of oil per brake horse-power hour. Kerosene, crude or fuel oil.

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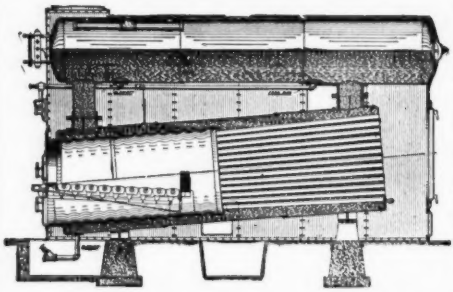

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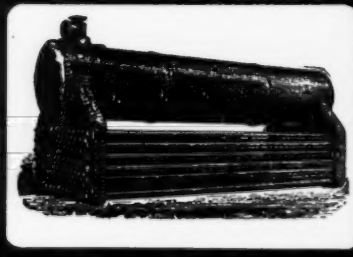

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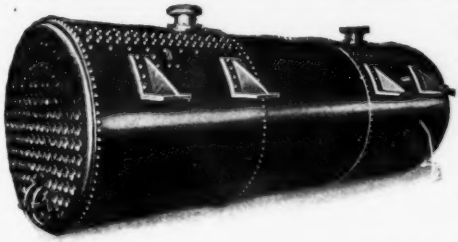

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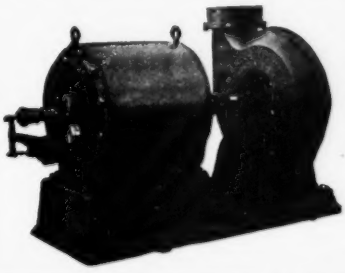

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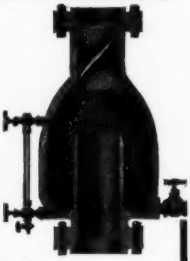

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It separates thoroughly by Centrifugal Force, the simplest and surest process known. No condensation—no shaking or vibration of pipes—no danger of throttle valve bursting, wrecking of engine, or loss of life—All "SWARTWOUT" SEPARATORS tested at 400° pressure an guaranteed for 150° working pressure Write today for illustrated descriptive booklet in detail. Better be safe than sorry.

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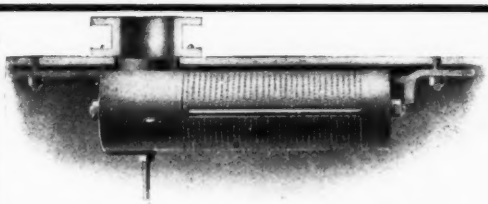

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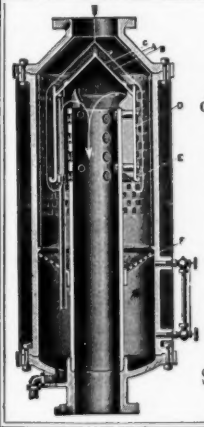

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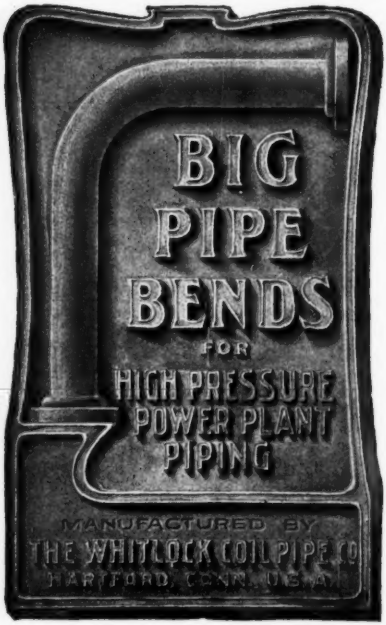

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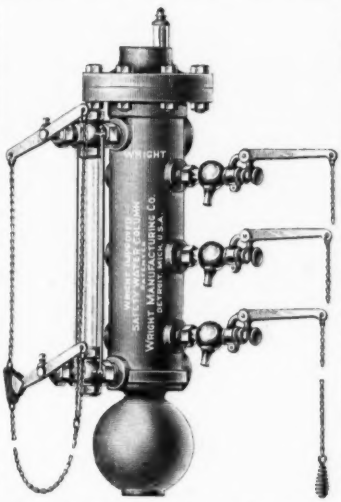

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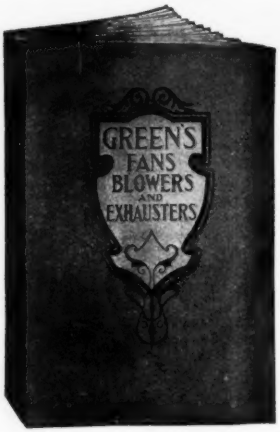

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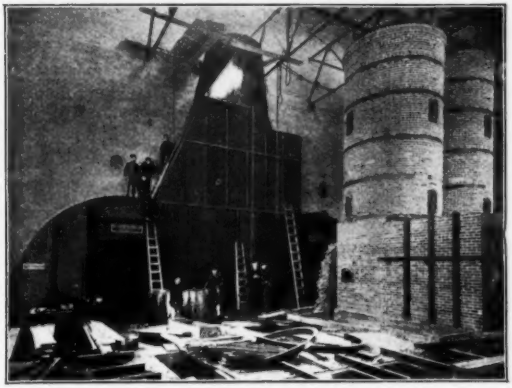

beats the chimney. Here is a boiler plant erected on the fourth floor of a large department store in Berlin where area is of the greatest value. Not a square foot of floor space is occupied; and the stack merely projects through the roof.

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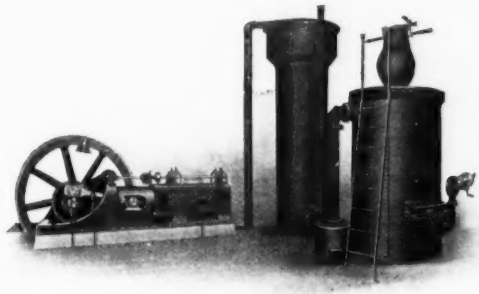

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1 lb. coal a horse power hour

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Our Gas Producers also make cheap fuel gas, which can be distributed in pipes and used for various kinds of heating and furnace work.

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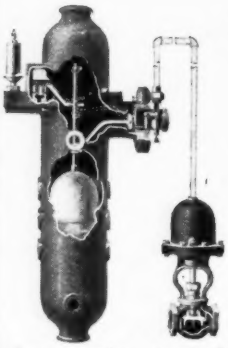

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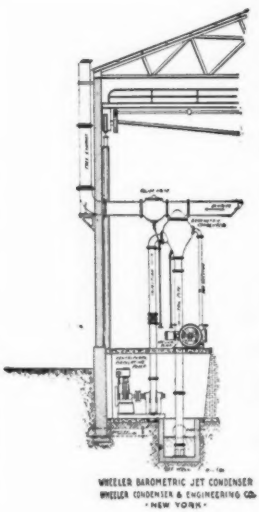

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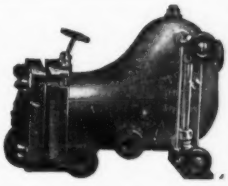

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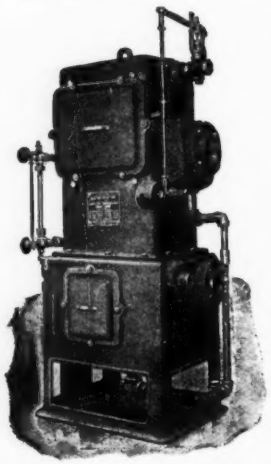

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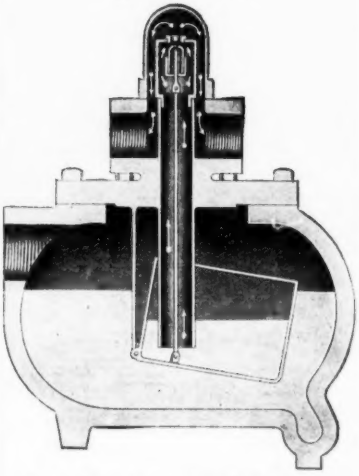

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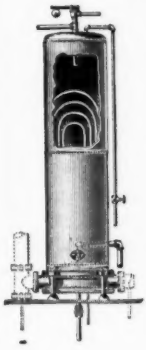

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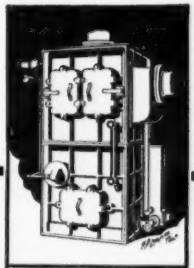

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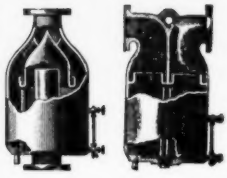

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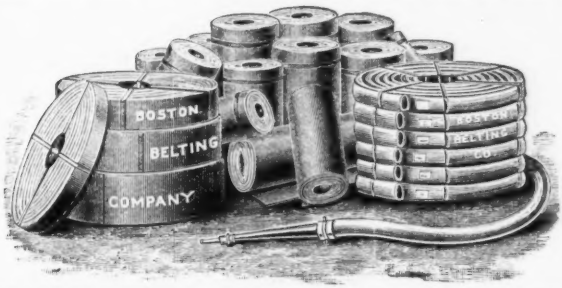

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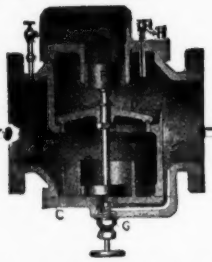

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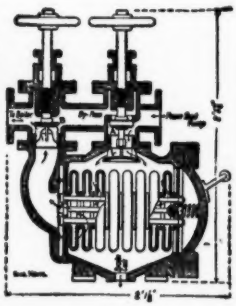

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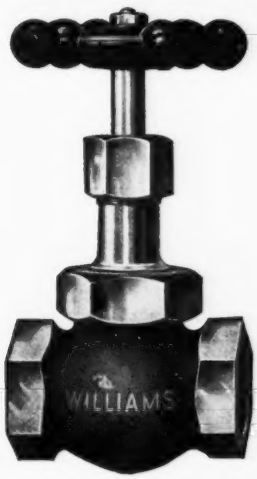

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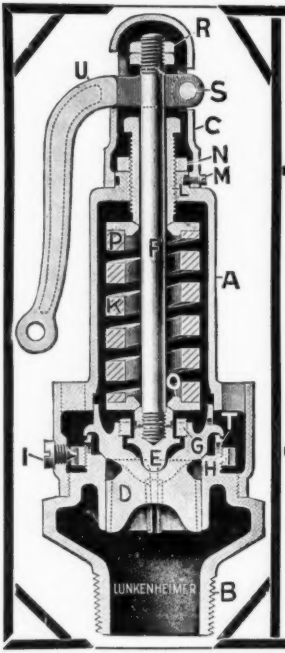

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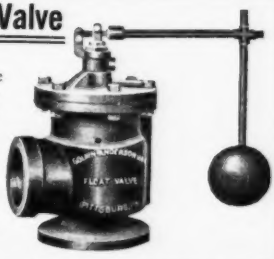

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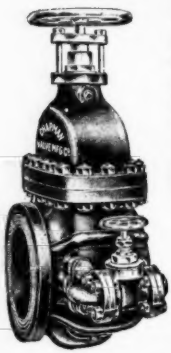

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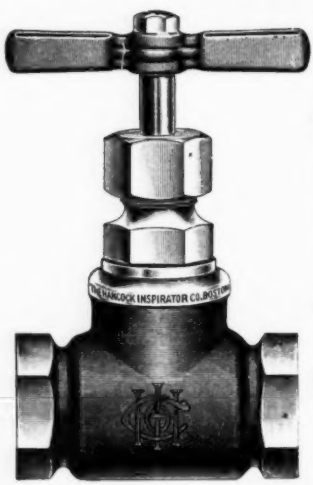

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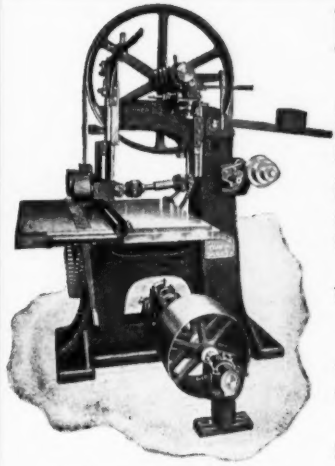

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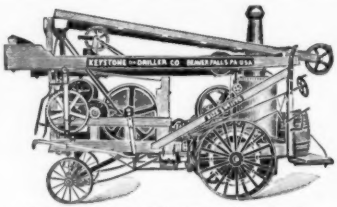

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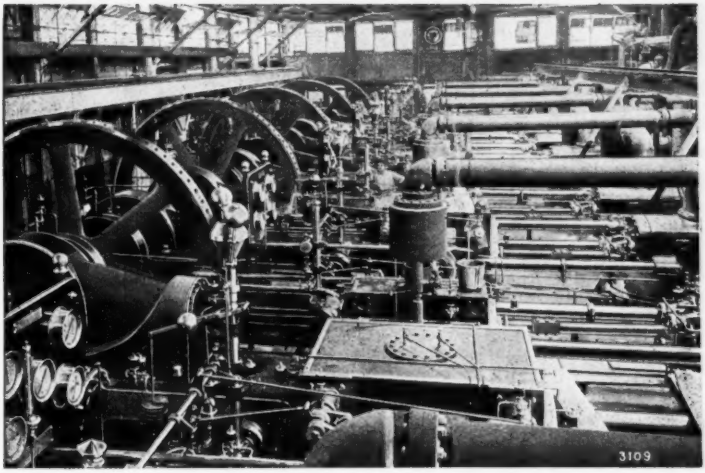

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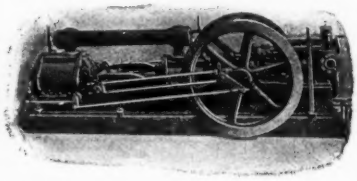

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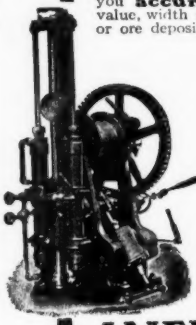

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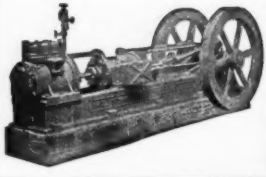

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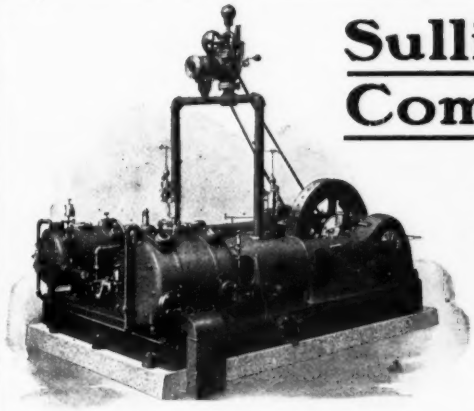

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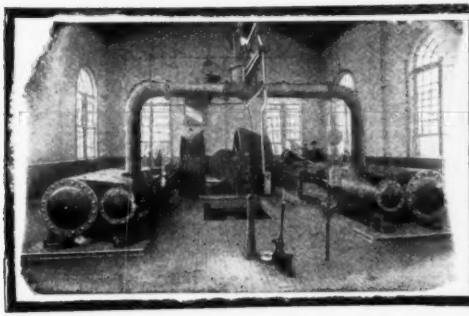

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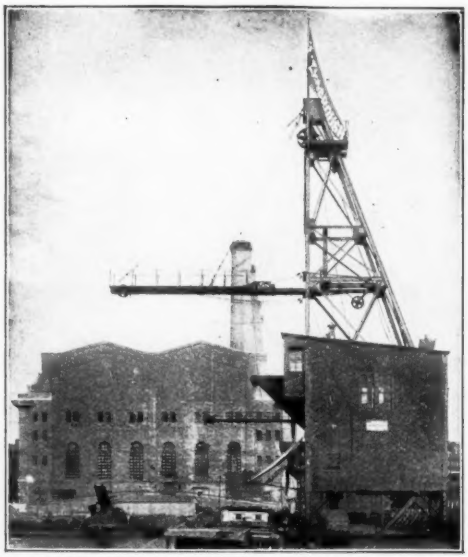

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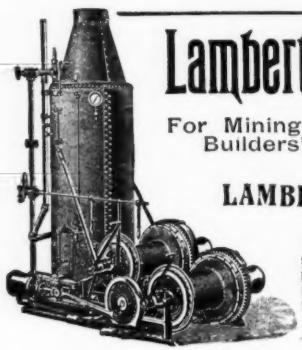

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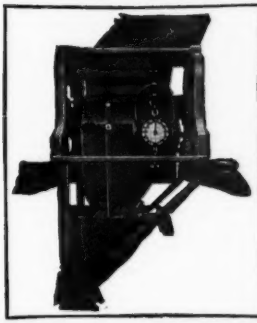

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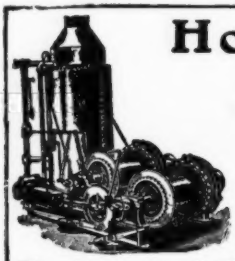

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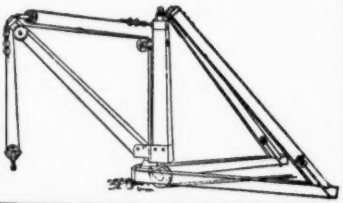

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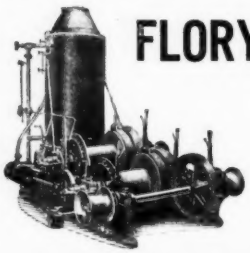

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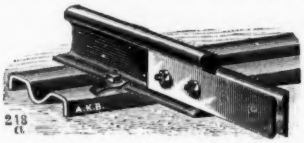

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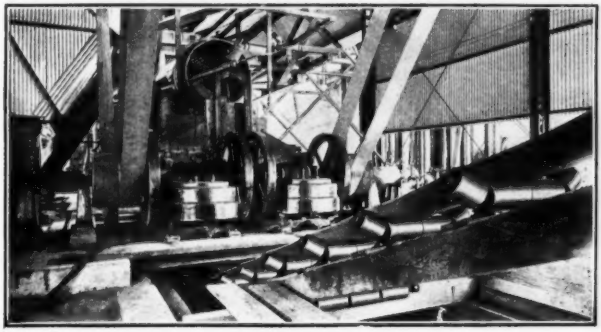

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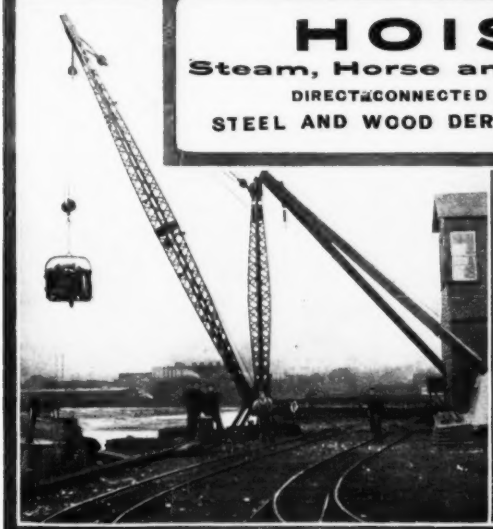

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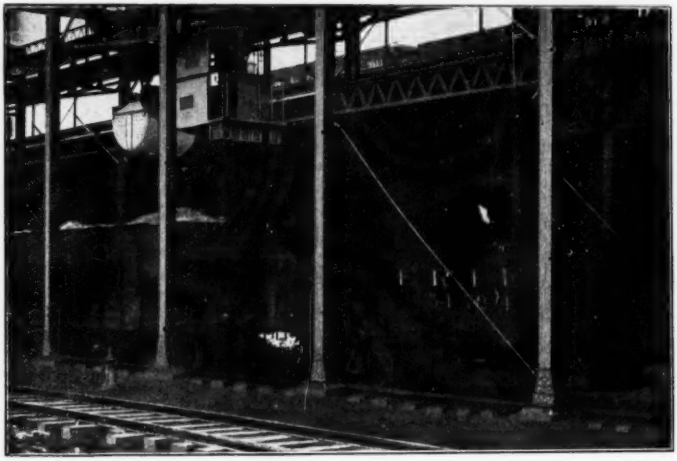

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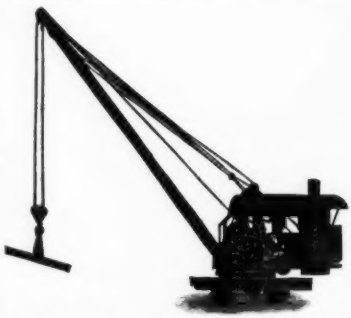

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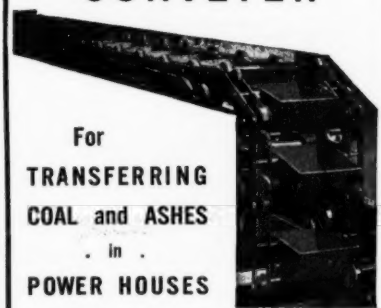

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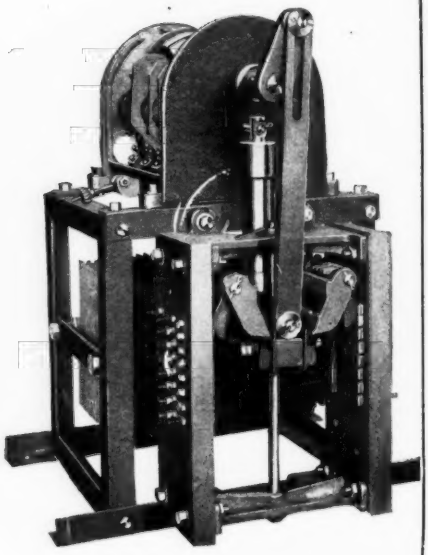

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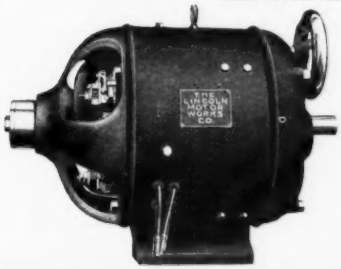

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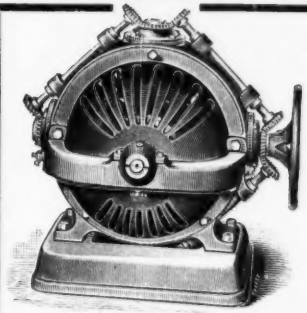

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Will stand short circuited for hours without injury and will be ready for operation the moment proper conditions are restored.

110 or 220v. D. C.

100 hour burn guaranteed

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Mechanism Protected from Dust

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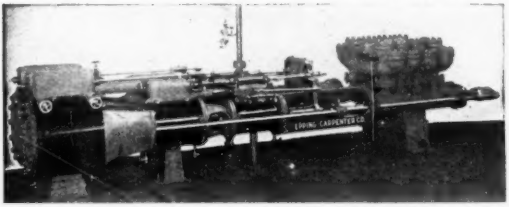

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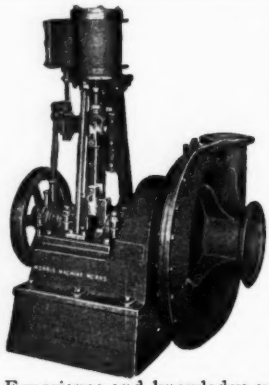

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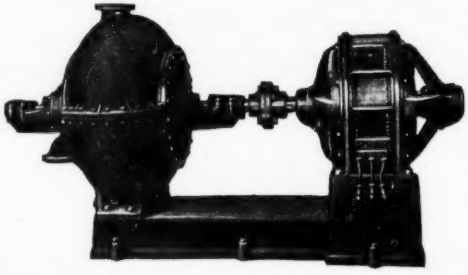

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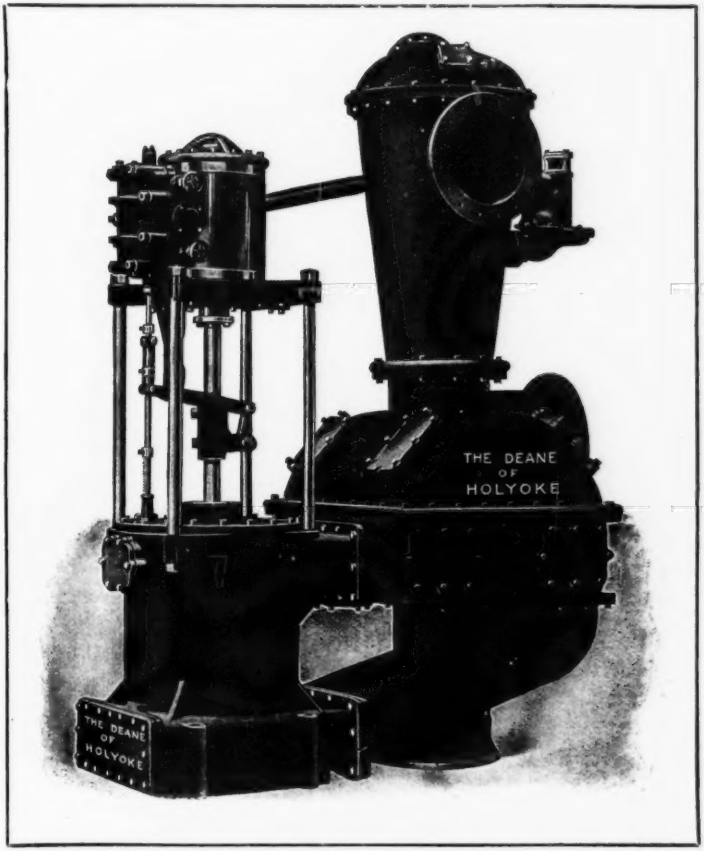

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Specials. Large Cylinders. Heavy Castings

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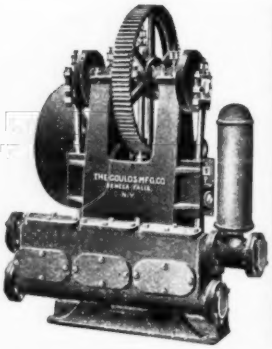

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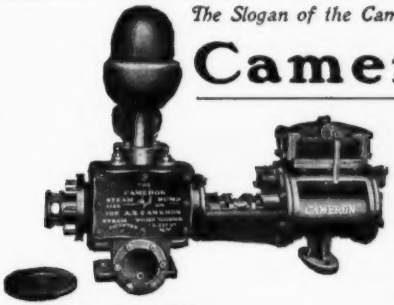

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If your water is very gritty and the use of a Plunger Pump is prohibited on account of the limited space or other circumstances, we suggest the adoption of our Piston Pump fitted with Removable Bushing of iron or composition.

This bushing can be turned in the pump so that the wear, which is usually greatest at the bottom, can be gradually distributed over every portion of its surface, thus allowing the greatest durability with this type of pump

The distinctive features of all CAMERON PUMPS are appreciated by Engineers and Pumpmen who have tried them out. Ask any one of them, also write for our Catalog, Edition "X," which contains useful information.

A. S. CAMERON STEAM PUMP WORKS,
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The Emerson Steam Pump

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all operations where reliability is essential. It has no packing glands, stuffing boxes, rubbing surfaces, exhaust pipe, rocker arms, pulleys, belts, fly wheels, priming pipes, no adjustments, makes no noise. We cut out all the troublesome parts that are necessary adjuncts to other pumps. It has more points of merit and less of demerit than any other. They will handle gritty material **without** damage to themselves that would destroy other pumps in short order. There is nothing made so reliable, nothing so simple or that will stand rough usage or exposure to all kinds of weather or that requires so little attention or so few repairs. Our catalogue explains it in detail.

Ask about our Quick Cleaning Strainers and Foot Valves. They are great, too.

THE EMERSON STEAM PUMP COMPANY
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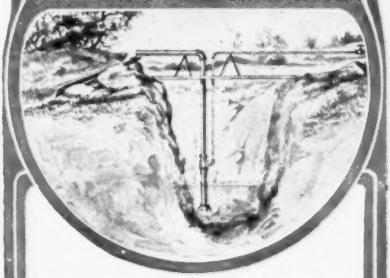

for elevating water for any purpose.

Less expensive than any other Steam Pump. No moving parts. Operated independent of any engine or motive power. Requires no oil, packing or care, anyone can operate it, set it up or take it down.

Can be used wherever there is room to lay the pipes. Will start as soon as steam is turned on and will continue to work without attendance. **Send for Booklet.**

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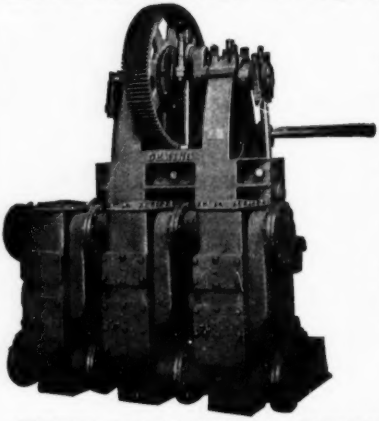

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For Mine, Mill and Factory.

Triplex Pump for boiler feeding and general service. Deep Well Pumps for pure water supply.

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THE "VORTEX" CENTRIFUGAL PUMP

There are so many places where the Vortex High Efficiency Centrifugal Pumps are most desirable that you should not fail to place your pump requirements before us.

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THE Engineering Index is a monthly directory to all the engineering literature worth reading.

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Engineers will be interested in this new HYDRO-ELECTRIC DEVELOPMENT.

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THE SIMPLE LIFE

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LOMBARD GOVERNORS.

They are simple in construction.

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LET US HAVE YOUR SPECIFICATIONS
SINGLE DUPLEX & ROTATIVE
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Are complete in themselves. No pumps or electric current required. The regulation is right and the price is right.

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The John McDougall Caledonian Iron Works Co., Ltd.,
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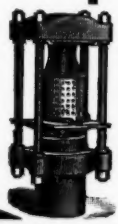
Our plant is equipped with every facility to design and construct any description of Hydraulic Machine. We can build from your own design, or design and build ourselves for you.

We manufacture a standard line of Pumps, Presses, Valves Punches, Shears, Benders, Shaft Straighteners, and nearly 300 varieties of Jacks.



Illustrated General Index, No. 65, Edition H, covering our lines—yours for the asking.

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Offices { **26 Cortlandt Street, NEW YORK**
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Coupons may be had in quantities at a reduction.
Their use is commended for the sake of convenience.

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THE ENGINEERING MAGAZINE
140-142 NASSAU STREET, NEW YORK

FLOORS

ROOFS

THE OPINION OF AN AUTHORITY.

An extract from the latest revised edition of Kidder's "Architects' and Builders' Pocket Book," Chapter XXIV.—"Fireproof and Incombustible Floors and Flat Roofs," under the head of "Welded Metal Fabric," pages 831 and 832:

"The Clinton Wire Cloth Company manufacture a welded fabric or mesh which has been extensively used in the United States as a reinforcement for concrete construction of all kinds.

"From a theoretical standpoint, at least, this fabric would appear to offer the ideal reinforcement for slab construction, as the carrying wires may be varied, both in size and spacing, to give the necessary area for any given weight and span, and the distributing or cross wires coincide with the line of stress, so that there is no tendency to distort the rectangle of the mesh.

"The cross wires, being welded to the carrying wires, are rigidly held in place and prevent the latter from slipping in the concrete.

"In the meshes most commonly used the carrying wires vary from No. 10 to No. 4, and from 1 to 4 inches on centres, while the distributing wires vary from No. 11 to No. 6, and from 3 to 12 inches on centres.

"Welded metal is manufactured in long rolls, and by its use, all joints and laps are avoided, and a floor can be made with a continuous metallic bond from wall to wall (i. e., when the mesh is laid over the top of the steel beams)."

Write for New Catalog of the Clinton Fire-proofing System

CLINTON WIRE CLOTH COMPANY
CLINTON, MASS.

Note the border surrounding this ad—a photographic reproduction of a section of Clinton Electrically Welded Fabric.

Sweet's Index, pages 96 to 103, describes the Clinton Fire-proofing System.

CEILINGS

Fire-Proofing Department
ALBERT OLIVER
1 Madison Ave., New York

Seattle: L. A. Norris 909 Alaska Building
St. Louis: Hunkins-Willis Lime & Cement Co. South End 18th Street Bridge
Baltimore: George T. Welsh Calvert Building
San Francisco: L. A. Norris 685 Monadnock Building

PARTITIONS

How a Saw Mill Plant Reduces the Cost of Concrete Buildings.

In last month's issue we explained one of our methods of reducing the cost of reinforced concrete buildings by the scientific testing of the concrete for the purpose of getting the most economic mixture of ingredients. While we have saved large sums of money for our patrons in that manner, we regard our plant for the making of the wooden forms, or molds, as being one of the greatest of money savers. Before starting the work of erecting a concrete building, our engineers go carefully over its design, and make drawings from which the lumber for the forms is framed. Did it ever occur to you that there is quite as much chance for an application of brains in the design of wood forms for a concrete building as there is in the design of a frame cottage? The cost of a reinforced concrete building is largely dependent upon the cost of the forms, hence it is the practice of Ransome & Smith to go into the design of forms with as great care as a bridge engineer would go into the design of a bridge. But the economy in forms does not end with their design. Our portable plants for sawing the forms to the lengths and shapes desired are likewise great savers of money, compared with the common method of framing forms entirely by hand. There are many contracting firms engaged in erecting reinforced concrete buildings upon the cost-plus-a-fixed-sum basis, as we are, but we do not believe that any other firm is equipped with so complete a plant for the making of forms. Indeed many firms operate with no saw mill at all, much to the loss of the owner of the building, not only in money, but in time. Since we, as contractors, furnish our plant and receive no pay for it except in the form of our profit—the fixed sum—the owner is the loser if our plant is poor, and the gainer if it is good. In a previous advertisement we showed how the owner saves money through our concrete testing plant, and we have now briefly indicated how a further saving is effected by our complete plant for raming the wooden forms. In subsequent advertisements we shall outline further advantages possessed by Ransome & Smith in the economic and rapid construction of reinforced concrete factories, office buildings, etc. Write for any desired information, photographs of buildings erected by us, etc.

RANSOME & SMITH

11 Broadway, - - - NEW YORK

KAHN SYSTEM
of Reinforced Concrete

The requirements of modern buildings are fully met by the **KAHN SYSTEM** of **REINFORCED CONCRETE.**

If **SPEED** is demanded it can be obtained in an unprecedented degree by the Kahn System, and yet this speed is accompanied by

PERFECT SAFETY when in the hands of experienced men exercising care in handling the details and giving proper attention to the requirements of the design.

STABILITY is equally a characteristic of this method of construction, and is testified to by the appearance all over the country of buildings having the enduring qualities of structures carved out of solid rock; in other words, monolithic in type and, therefore, best adapted to withstand the attacks of time and other destructive elements.

The Kahn System is based on the use of the Kahn Trussed Bar, with rigidly attached shop-prepared diagonals, whereby the cost of installing is reduced to the lowest possible point and the highest degree of reinforcing efficiency is secured.

The Kahn System is endorsed not only by official tests, but by the even more convincing tests of actual practice—structures now in daily use and open to public inspection and investigation. For example: such buildings as the United States Naval Hospitals at Washington and Annapolis, and numerous other Government buildings; the Farwell, Ozmun & Kirk Co. Warehouse, St. Paul, Minn.; the immense automobile plants of the Cadillac, Packard, Pierce, Garford, and Thomas companies, and hundreds of other structures, including warehouses, factories, office buildings, railroad roundhouses, coal breakers, bridges and viaducts.

During the coming year we will continue the publication of the "Trussed Concrete Bulletin," and if you will write your request on your business letter head, we will be pleased to place your name upon our mailing list.

Trussed Concrete Steel Company

41 Congress Street

London **DETROIT** **Toronto**

What the Busy Manufacturer Needs

Of course, you need additional factory space to keep up with your orders.

Of course you need that space laid out so that you can turn out the largest possible product with the greatest possible economy.

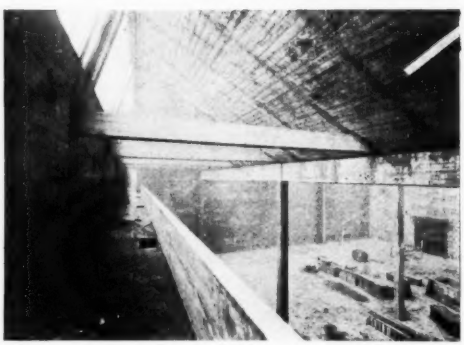
Of course you are using all of your capital and you cannot afford to tie up an unnecessary dollar in the building.

Of course you need that building now.

Under our contract, we can commence excavating within forty-eight hours after you retain us, and while the building plans are being made.

We can build you a fireproof, vibration-proof factory in concrete for practically the cost of a timber mill building.

We can complete the work in less time than would be required for the timber mill building.



One of the five main buildings at Stollwerck Brothers' Factory, Stamford, Conn., showing the fifty-foot spans. Photograph taken from inspection walk which runs the entire length of the building on top of the concrete hot air duct. This latter is also on fifty-foot spans.

TUCKER & VINTON
4 West 22nd Street
New York
STEEL CONCRETE

What Tucker & Vinton Supply

In this advertisement, there is only space enough to go into detail on one feature of our business.

The factory we are now completing for Stollwerck Brothers, Chocolate Manufacturers, in Stamford, Connecticut, is an extreme example of the adaptability of concrete construction to the specific requirements of any business. The floor loads of the machinery in this class of work are very great—in a large part of the building 1,200 lbs. to the square foot is what the floors will have to bear. The machinery is large and requires a great deal of column free space—the spans in the main building are 50 x 25 in the clear. Most important of all, the manufacture of high grade chocolate can only be accomplished at an even and comparatively low temperature. The Stollwerck Factory has hollow concrete walls and a hollow saw-tooth roof, the only light being from north skylights. These present a few of the many requirements that we meet in the construction of the Stollwerck Factory.

The Unit Girder reinforcement in place on the roof forms ready for the pouring in of the concrete. Attention is called to the method in which the reinforcement for the beams locks into the main fifty-foot girder.

The hollow saw tooth roof. The main slab, 2" thick, is attached to the bottom of the girders. The upper slab cast independently and laid on in squares.

Our cost plus a premium contract puts us on the owners' side of the fence. Instead of our profit being dependent on our ability to make the owner accept the least amount of work for the largest amount of money—Our profit depends on our ability to get the owner the largest possible return on the smallest possible investment.

We want the opportunity to demonstrate personally the facts about concrete construction and especially about Tucker & Vinton concrete construction.

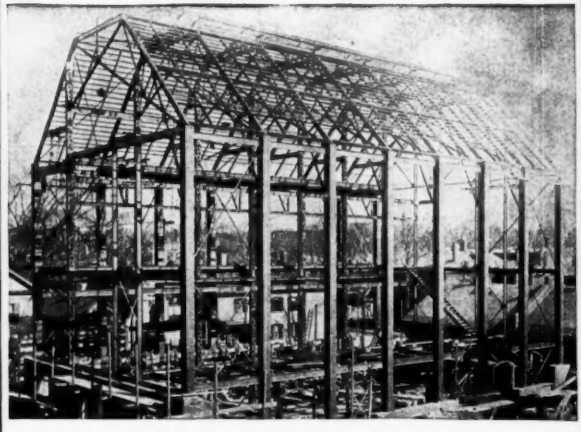
You make the date, we will keep it.

TUCKER & VINTON
4 West 22nd Street
New York
STEEL CONCRETE

STRUCTURAL
STEEL WORK

Steel Frame Buildings

Complete Plants Designed and Erected
Steel Concrete Construction



Retort House, Springfield Gas Light Company,
Springfield, Mass.

BUILT BY BERLIN CONSTRUCTION COMPANY

BERLIN CONSTRUCTION CO

Please mention The Engineering Magazine when you write.

Does the Ransome Tilt?

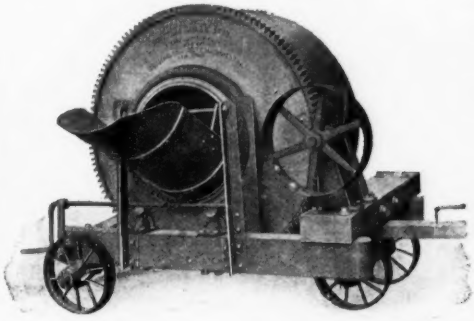
NO!

Batch mixers may be divided into two classes: 1st. The Tilting Mixer; 2d, The Non-Tilting, or Ransome Mixer. A tilting mixer is one that tips up, or tilts, to discharge the batch of mixed concrete. A tilting mixer is open to numerous objections, some of which are:

1st. Smaller output due to the time lost in tilting, particularly when loading into wheelbarrows.

2d. Complicated mechanism, which not only increases the first cost of the mixer, but the cost of maintenance.

3d. Must be mounted higher from the ground to give "clearance" for tilting, which necessitates elevating the materials higher. This is particularly objectionable where the mixer is charged from wheelbarrows or carts.



4th. Greater internal wear of the mixer due to the abrasive sliding of the materials when the mixer is tilted.

5th. Poorer quality of concrete for any given period of mixing, due to the lost time during the period of tilting.

On the other hand, the Ransome mixer does not tilt and is subject to none of these economic disadvantages.

If you are interested in an analysis of the different types of mixers, send for our "Handbook of Concrete Machinery."

Ransome Concrete Machinery Co.,

11 BROADWAY, NEW YORK CITY

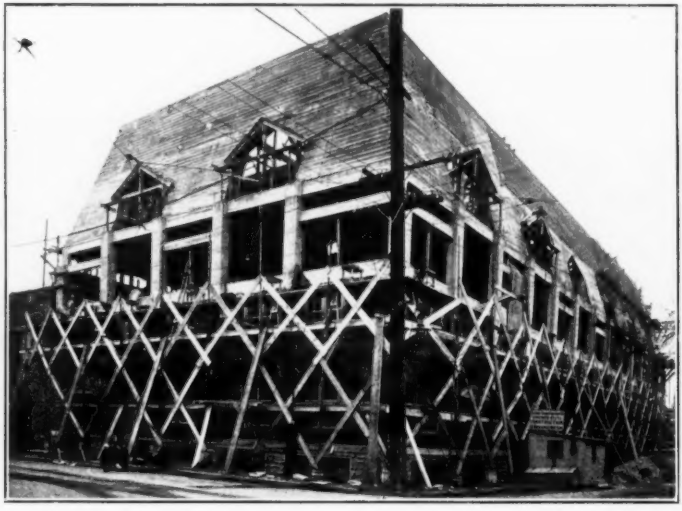
On and after March 25th, 1907, the main office will be located at our new plant at Dunellen, N. J., where all correspondence should be directed.

Please mention The Engineering Magazine when you write.

Reinforced Concrete

FOR

Factories and Warehouses



We are making a specialty of large buildings requiring a high classed organization and plant. Among the principal companies for whom we have done work may be mentioned the following:

Robert Gair Co. factory, G. Schirmer factory, J. B. King & Co. buildings, Eastman Kodak Co. buildings, Bush Model factories, Keuffel & Esser factories, Murphy Varnish Co. factories, Eastern States Refrigerating Co. Warehouse.

Turner Construction Company

Engineers and Contractors

11 BROADWAY : : : : NEW YORK

ABERTHAW CONSTRUCTION CO.

8 Beacon Street, Boston, Mass.

Concrete Engineers and Contractors.

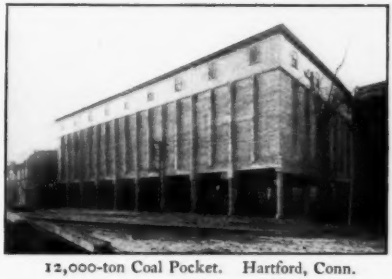
In our thirteen years of specialized practice, we have designed and built some of the most noteworthy structures in the world.

Residence, Port Antonio, Jamaica, B. W. I. Elaborate ornamental interior. One of ten buildings we built that were severely shaken but entirely undamaged by the recent earthquakes.

The largest concrete standpipe in the world, 50′ dia. x 118′ h. Capacity 1,500,000 gals. Waterproofed with concrete 18″ thick. Attleboro, Mass.

Spark arrester, S. D. Warren Co., Cumberland Mills, Me. Flue 11′ dia. x 100′ h., hung from roof of spark chamber 30′ above ground (where shown).

Gravity Dam, 270′ l. x 35′ h. Sheldon Springs, Vt.



12,000-ton Coal Pocket. Hartford, Conn.

Form of contract to suit owner; we have worked under all.
We cannot tell you all here; send for catalogue E M.

Restaurant Building of General Electric Co., Schenectady, N. Y.
Built of Blocks made on Hercules.

THE HERCULES DID IT

The new Hercules catalog is a beauty—it tells lots of things about Concrete Construction that every contractor, architect and builder should know. Sixty-six pages of meaty matter, including fifty illustrations.

The Chicago Cement Convention proved one thing—that the

HERCULES CEMENT STONE MACHINE

is still 365 days ahead of them all. It makes more sizes and larger variety of blocks than any other machine. It makes two blocks of the same size and design or of different sizes and designs on the one machine at the same time. It is the simplest machine in the world—no pins, cogs, chains, springs or levers.

In strength, durability and adaptability it leaves all others far behind. Send for catalog "O" today. It's free to anyone interested in concrete construction.

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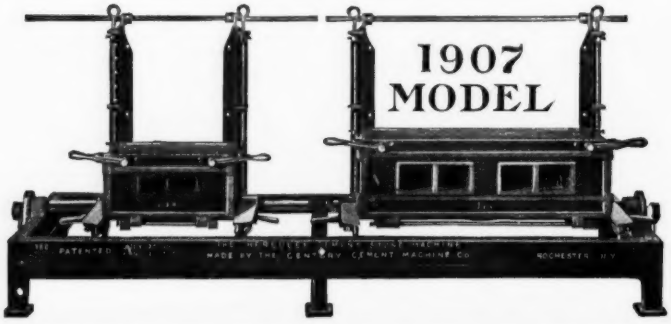

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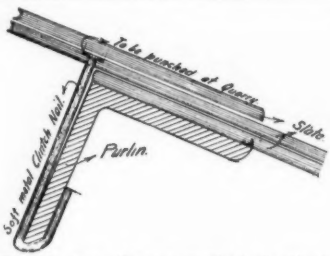

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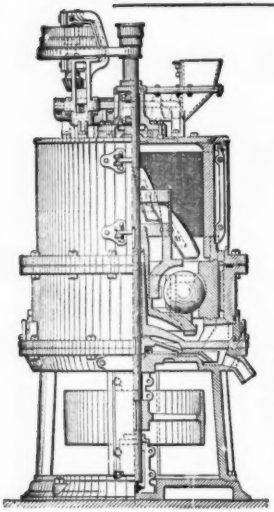

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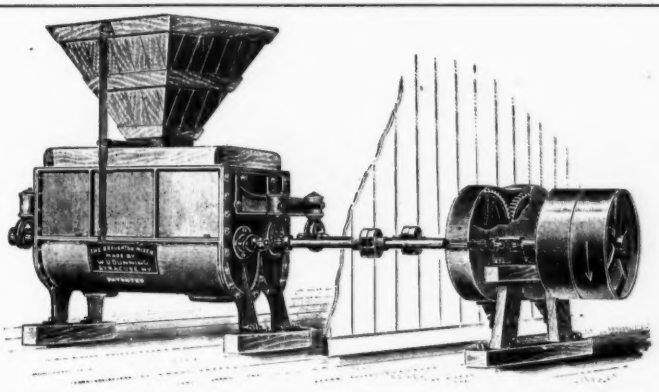

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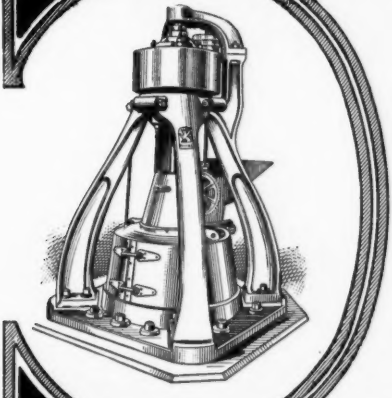

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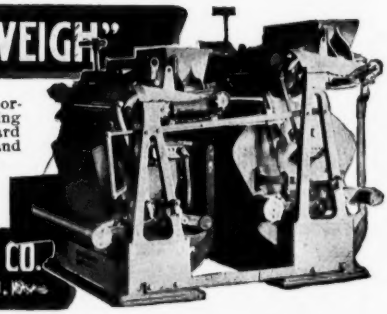

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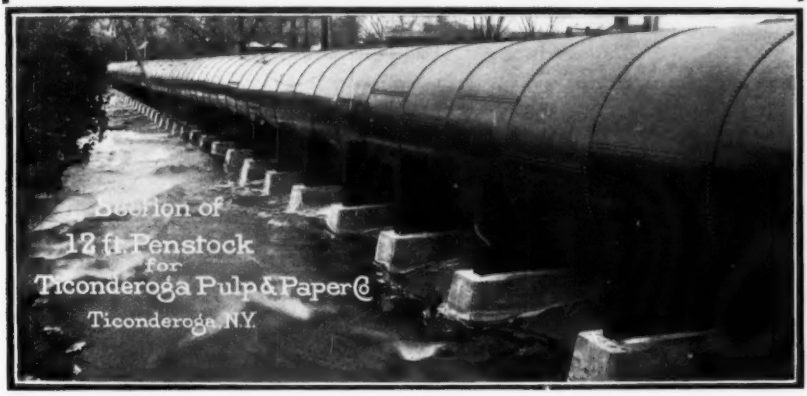

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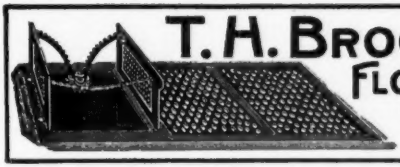

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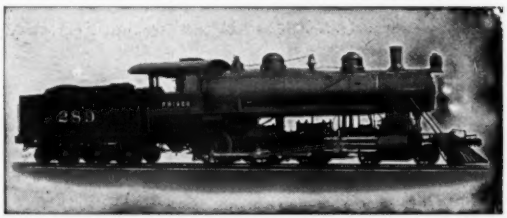

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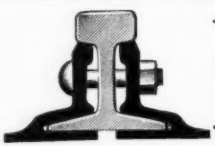

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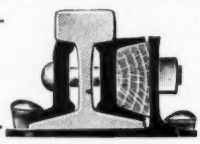

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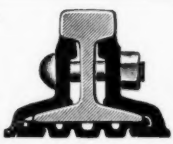

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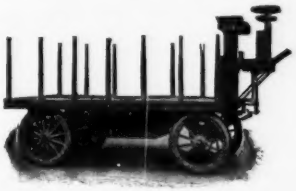

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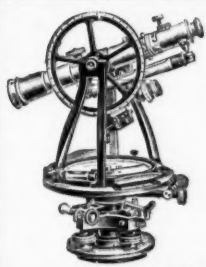

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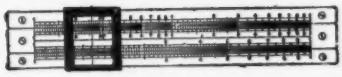

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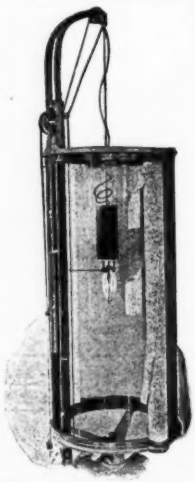

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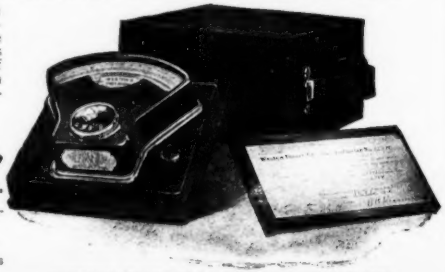

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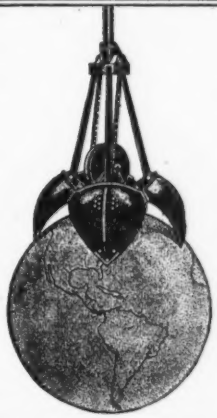

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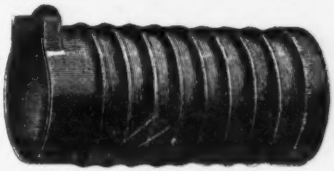

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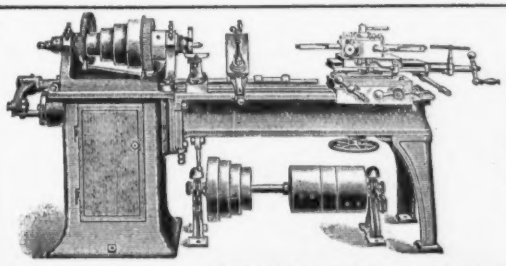

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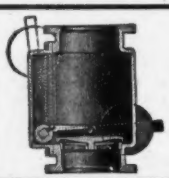

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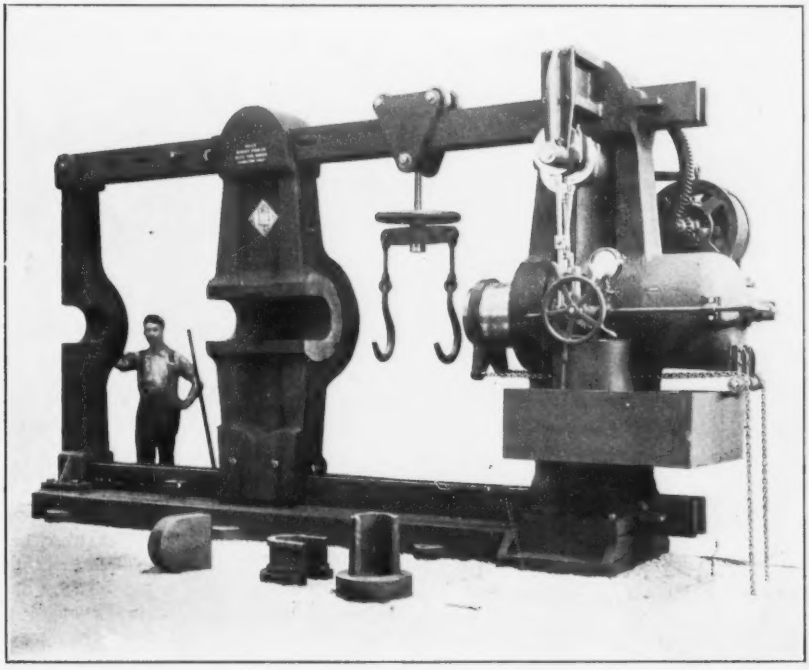

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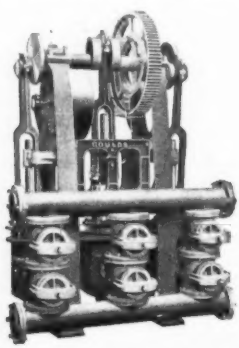

they will pump more water for the amount of power expended than pumps of other types, and when it is taken into consideration that one of these pumps driven by an electric motor will cost for power only from 1⅛ to 3 cents per horse-power-hour, or only what coal alone at $3.00 per ton would cost to run a steam pump of most modern design, it will be readily seen that the triplex pump is a most effective and economical apparatus. In addition to this the electric pump can be arranged to start and stop automatically, as the demands of the service may require, or the pumps in various parts of buildings can be controlled from some central station if desired. The Goulds Manufacturing Company, Seneca Falls, N. Y., are the original builders of triplex pumps in this country.

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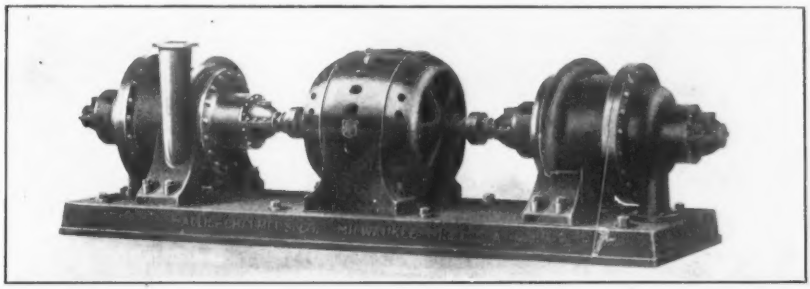
The Allis-Chalmers Co., Milwaukee, one of whose small units is illustrated herewith, designs these pumps for any capacity and condition of service within the range of their adaptability, and the construction of each is planned with careful reference to the requirements of the service for which it is intended. They may be used in mining operations, for irrigation work, for auxiliary pumping stations in cities, for municipal fire service, for feeding boilers, or for any other service of a similar nature. The pumps are built with as many runners as there are stages through which the water is required to be handled, each stage raising the total required quantity of water through

its proportion of the total net head. The runners are designed after the well-known "enclosed" type, the water entering and leaving each runner axially. All of the runners are mounted on a common shaft. A stationary guide wheel is introduced between each runner, the function of this wheel being to take the water from the tips of the vanes of one runner and conduct it through suitably designed passages to the inlet side of the succeeding or next runner. After the water has passed through the last runner it is guided into the volute shaped casing. Particular attention is given to securing for these pumps casting of smooth surface, free from irregularities, in order to reduce the hydraulic friction to a minimum; and of these portions of the interior of the pump casing and runners through which the water passes at high velocity all accessible parts are machined. The waterways are of relatively large area, and the contour of the vanes is such as to produce the best results for the particular service required. The pump remains in lateral balance under varying loads and conditions. When properly adjusted, these pumps will run smoothly, without undue jar or vibration, and care has been taken in their design to secure the highest possible efficiency, strength, durability and accessibility. The pumps may be driven either by induction or direct current motors. Both pump and motor are mounted on a common bedplate.

The electrically driven pump has a number of important advantages. One of these is that, on account of the high rotative speed, less work needs to be done for each revolution, thus reducing the size of the unit. Pumps directly connected to electric motors are also flexible in their operation. As the speed is constant, the power and output are in inverse ratio to the head pumped against, so that the efficiency remains practically constant within the limits for which the pump is designed. Then, too, the speed necessary for operating under high heads can be obtained without increasing the impeller diameter of the pump to such an extent as to render its construction impracticable. Further, it sometimes becomes necessary to erect pumping machinery at a distance from the source of power, and in such cases the use of electric current greatly simplifies the problem of construction.

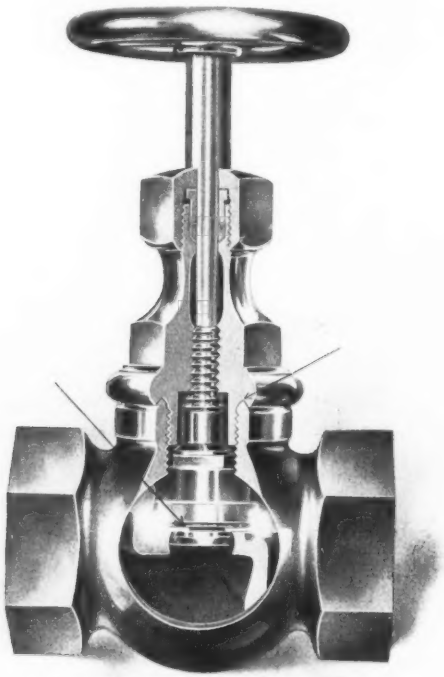


Golden Clean Seat Valves.

THE Golden Clean Seat globe and angle valves are made screwed and flanged ends up to 3". These valves are of a heavy pattern, first class material and workmanship, and correct mechanical construction. Referring to the sectional cut, interest at once centers in the disc, seat, bonnet joint, and the general substantial construction throughout. The diaphragm is made very heavy to prevent springing, thereby compelling the disc always to seat squarely. Attention is called to the valve or disc wherein exists the positive self-cleaning of the seat and disc. The bottom of the disc is hollow with solid cast eccentric lugs on the side. The slot or groove is cut through between the lugs, also the entire outside diameter, consequently when the slot or groove comes flush with the seat, the steam, water, or air blows or jets directly across the seat and disc, absolutely cleaning them all of sediment just before closing. This projection on the bottom of the valve or disc is very

important, as it acts as the first cut-off or throttle in protecting the seat and disc against ruinous effects of wire drawing of the steam. This construction of the valve disc is especially important, when the valve is cracked or slightly open, as the projection is large and substantial, and the bottom of the disc being hollow, the steam or water will jet through the slot or groove without any injury to the seat and disc.

ing to the very heavy construction, this valve will resist the stress and strains at this vital point. This is a decided improvement over any other form of bonnet joint. These valves are made in the extra heavy pattern suitable for 275 pounds working steam pressure, tested with 1,000 pounds water pressure and also made for hydraulic and compressed air service for all pressures including 2,500 pounds. A variation is the



Another important feature is that the valve can be packed when open as the back of the valve disc is faced and comes to a seat on the bottom of the bonnet. The valve seat is flat and narrow, having many advantages over any other form. The bonnet of this valve is made with a long thread engaging the body of the valve with a bevel joint, insuring a tight joint. Owing

Golden Clean Seat boiler blow-off, which has the same simple and positive feature of self-cleaning the seat and disc. The body of the valve being iron or steel is fitted with renewable bronze seats and solid bronze valve or disc. These valves are made by the Golden-Anderson Valve Specialty Co., Fulton Building, Pittsburg, Pa., who will furnish fuller information on request.

NEWS SUPPLEMENT

The Engineering Magazine—October, 1906

Personal.

—J. F. Davis, formerly connected with the Pittsburgh office of the Atlas Engine Works, Indianapolis, has been transferred to the Company's offices at Chicago.

—Mrs. Francis A. W. McIntosh, formerly advertising manager of the Standard Tool Co., Cleveland, and more recently connected with the advertising department of Power, New York, now has charge of the publicity department of the Norton Co., Worcester.

—J. P. Johnston, for several years past the general sales manager for the Weber Steel Concrete Chimney Co., Chicago, has resigned to become sales manager, Water Tube Boiler Department of the Atlas Engine Works, Indianapolis. Mr. Johnston's offices will be at the Company's plant in Indianapolis.

W. H. Whiteside, president of the Allis-Chalmers Co., Milwaukee, returned recently from a two months' combined business and pleasure tour of England, France, Germany and Switzerland. Mr. Whiteside inspected various large manufacturing industries of England and on the continent. Among them he visited the plants of the leading English steam turbine builders, whose American rights for building Parsons steam turbines for marine and land use, are enjoyed by the Allis-Chalmers Co.

—R. E. Mathot, Member American Society Mechanical Engineers, an expert in gas engines and author of several works and lectures on gas engines, producers, and automobiles, author of "Gas Engines and Producer-Gas Plants," will make his annual trip in America in November. Those interested in his specialities who would like to meet him for consultation regarding improvements in their construction or plants may write to him for an appointment, to American Society Mechanical Engineers, 12 West Thirty-first Street, New York.

Industrial Notes.

—The new 12 stall roundhouse for the Southern Railway Co., Asheville, N. C., is to be equipped by the B. F. Sturtevant Co., Boston, with complete heating system.

—Bethlehem Foundry & Machine Co., Bethlehem, announces that Frederick W. Conlin has been appointed vice-president and general sales manager, J. George Lehman as manager and Ira E. Krause as secretary and assistant manager.

—Owing to the increasing demand for its product throughout the Southern States, the Chicago Pneumatic Tool Co. have opened an office 1012 Memphis Trust Building, Memphis, Tenn., in charge of J. Francis Small.

The Buffalo Forge Co., Buffalo, report an increasing business in Japanese export trade, and have recently closed a contract with Mitsui & Co. for 36 extra heavy smith-shop forges, 17 large railroad forges and 5 two-section heating furnaces.

—The R. D. Nuttall Co., Pittsburg, have ordered equipment for their small gear department, particularly for the manufacture of automobile gears, which will practically double the output of bevels and worm gearing.

—The boiler room equipment of the Kansas City Portland Cement Co., Independence, Mo., will include two standard economizers and an induced draft apparatus consisting of two steel plate fans with direct-connected engines, all to be manufactured by the B. F. Sturtevant Co., Boston.

—The Kilburne and Clark Co., Seattle, have recently placed a large order with the Electric Cable Co., New York, for the Voltax liquid compound to be used as a waterproof paint for the protection of railway bridges which this company has in course of construction on the Pacific coast.

—Buell & Mitchell, 120 Liberty Street, New York, have been appointed New York representatives for the Scaife water filters, manufactured by Wm. B. Scaife & Sons Co., Pittsburgh. A large display room will be maintained, showing the various styles and sizes of filters in actual operation.

—The Ransome & Smith Co., New York, has closed a contract with the Coe Brass

Mfg. Co., Torrington, Conn., for the construction of a new 50x140 ft. three story machine shop and a new 50x140 ft. two story blacksmith shop to be built of reinforced concrete throughout.

—The Stayman Manufacturing Co., Jersey City, has just awarded to the Underwriters Engineering and Construction Co., New York, a contract for the construction of a large machine and forge shop. The buildings throughout will be constructed of reinforced concrete.

—The Buffalo Forge Co., Buffalo, have recently closed a contract with the Bethlehem Steel Co. for forced draft equipment, consisting of six fans and engines (direct connected) to drive the same. There is included in the contract provision for complete accessories in the line of dampers, speed regulating valves, piping, ducts, etc.

—Forge exhaust and blast apparatus, furnished by the B. F. Sturtevant Co., Boston, is being installed by the Morse Twist Drill & Machine Co., New Bedford; Brown & Sharpe Mfg. Co., Providence; Providence Technical High School, Providence; C. B. Hutchinson, Lyndonville, Vt.; Lynn Manual Training School, Lynn.

—The Chicago Pneumatic Tool Co., Chicago, announce the fact they have received from the printers their new compressor catalogue, consisting of 118 pages—printed two colors—in which several new types and sizes of compressors are shown, including their new Hamilton Corliss machines Those interested will receive copy upon request.

—The Borough of Kutztown, Pa., after operating a municipal lighting plant for some time is increasing its capacity by the installation of a 125 H. P. "Hornsby-Akroyd" oil engine. The present plant consists of a 65 H. P. "Hornsby-Akroyd" oil engine belted to generator. Both engines supplied by the De La Vergne Machine Co., New York.

—The Atlas Engine Works, Indianapolis, whose Chicago Sales Offices have for several years past been in suites 900-902 Fisher Building, will, upon completion of the new Fisher Building in November, increase their present quarters by the addition of several larger offices. Frank H. Baker will continue aat the head of the Chicago organization.

—The popularity of the new Sturtevant enclosed engine, with forced lubrication and watershed partition, is shown by recent sales, among which may be included the Jeansville Iron Works Co., Hazelton, Pa.; Mutual Wheel Co., Moline, Ill.; Rand-Avery Supply Co., Boston; Wood Worsted Mills, Lawrence, Mass.; W. W. Gleckner & Sons Co., Canton, Pa.; MacArthur Bros. Co., Glen Lyn, Pa.; Thomas Smith, Chicago.

—The Bridgeport Theatre Co., Bridgeport, are now manufacturing concrete blocks for the erection of a large theatre. It is estimated that 50,000 blocks will be required, together with 1,500 feet of water table, sills, etc. It is stated that this is to be the first of a chain of theatres to be erected of concrete blocks throughout the East. Hercules machines made by the Century Cement Machine Co., Rochester, are being used exclusively.

—L. O. Koven & Brother, New York, have broken ground for the erection of a machine shop. This building will be located in Jersey City to the south of their Plate Steel Works. The building will be of mill construction and will have a height of five stories. The shop is to be used for turning out special machinery used in connection with the sheet steel and plate steel work manufactured by this firm. It will be fitted up with the best tools required for doing a very large range of machine work.

—The Philadelphia and Reading Railroad have just placed an order for heating and ventilating equipment for use in the additions they are making to their machine and boiler shops. The contract awarded to the Buffalo Forge Co. includes six immense fans, heaters, tempering coils, piping, etc. The heaters are arranged for use with atmospheric pressure steam in connection with the Warren Webster vacuum system. The fans are to be belt driven from electric motors.

—De La Vergne Machine Co., New York, reports the following among other recent orders received for "Hornsby-Akroyd" oil engines: Central New England Ry. Co., Hartford, 7 h. p. geared to pump; F. J. Stokes Machine Co., Philadel-

phia, 25 h. p.; Hastings Pavement Co., New York, 16 h. p.; W. F. Norman Sheet Metal Mfg. Co., Nevada, Mo., 50 h. p.; Union Ballast Co., New York, one 20 h. p. and one 32 h. p.; D. P. Forst & Co., Trenton, 13 h. p.; Webb Wire Works, New Brunswick, 32 h. p.; J. W. Lippincott, S. P. Scott & Max Meyer, Little Rock, Ark., 50 h. p. engine to drive a De La Vergne ice machine.

—Ball Engine Co., Erie, Pa., report among recent orders the following: One 700 H. P. cross compound for City of Aurora. One 800 H. P. cross compound for National Tube Co., Pittsburg. Two 700 H. P. cross compound for Duluth & Iron Range Ry., Duluth. One 600 H. P. cross compound for Flint Lt. & Pwr. Co., Flint, Mich. One 700 H. P. cross compound for Pennsylvania R. R. Co., Altoona, Pa. One 550 H. P. single cylinder for Washington Elec. Light & Power Co., Washington, Pa. One 550 H. P. single cylinder for Natalbany Lum. Co., Montpelier, La. One 400 H. P. single cylinder and one 320 H. P. single cylinder for Craddock-Terry Co., Lynchburg, Va.

—The Wile Power Gas Co., Rochester, report the following recent orders for their automatic pressure and suction gas producers: 300 H. P. automatic pressure producer for Penn. Hardware Co., Reading. 750 H. P. plant for Edison Phonograph Co., Orange, N. J.; plant composed of a battery of three 250 H. P. automatic pressure producers to furnish gas for fuel purposes, replacing illuminating gas. 150 H. P. suction gas producer for Columbia Nut & Bolt Co., Bridgeport, to drive four cylinder producer gas engine. 400 H. P. automatic pressure producer for Superior Steel Co., Carnegie, Pa. Battery of two 200 H. P. producers to furnish gas for fuel purposes to take the place of natural gas. 60 H. P. suction gas producer for Ransome Concrete Machinery Co., Plainfield, N. J., to drive two-cylinder producer gas engine.

—The Carborundum Co., Niagara Falls, has started construction work on a large branch plant in Germany. This company is the sole American manufacturer of carborundum in the various forms in which it is used for grinding purposes, and the demands of its European trade have increased so rapidly that the establishment of a branch works on the Continent has become absolutely necessary. A German company has been formed under the title "Deutsche Carborundum Werke, G. m. b. h." The new works are located at Reisholz, a manufacturing suburb of Dusseldorf. The construction of the new plant is under the supervision of one of the American engineers of the Carborundum Co. Five kilns for the manufacture of vitrified wheels are provided for, two of these to be built at once. The buildings when completed will embody all of the latest and most improved machinery for the manufacture of abrasive materials. It is expected the new works will be in operation by January 1, 1907. The Carborundum Co. has for some time maintained large stores in London and Berlin and has agencies in most of the principal cities of Great Britain, Germany, Denmark, Norway, Sweden and Russia. With the completion of the German works, the European business can be largely increased on account of the better service that can be given.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Blue Print Machines.

J. H. WAGENHORST & Co., Youngstown.—Circular containing an illustrated description of electric blue printing machines. It also contains many testimonial letters, a list of users and prices for the various types of machines.

Boring Machines.

BARRETT MACHINE TOOL CO., Meadville, Pa.—Catalogue No. 6 illustrating and describing horizontal boring machines, together with many testimonial letters from users. 10½ by 7½ in.; pp. 46.

Cement Stone Machine.

CENTURY CEMENT MACHINE CO., Rochester.—Catalogue illustrating and describing cement stone machines and showing the many different designs of stone this machine can produce. 8 by 10 in.; pp. 68.

Drilling Machines.

H. G. Barr, Worcester.—Five loose sheets illustrating and describing sensitive drills and drilling machines, together with specifications. 8½ by 11 in.

Drill Presses.

Henry & Wright Mfg. Co., Hartford.—Catalogue illustrating and describing ball bearing drill presses and filing machines. 6 by 9 in.; pp. 20.

Electric Equipment.

General Electric Co., Schenectady, N. Y.—Bulletins Nos. 4443, 6, 7, 9, and 50 treating of controllers, motors, feeder panels, plug switches, and railway motors respectively.

Exhaust Heads.

Ohio Blower Co., Cleveland.—Small booklet illustrating and describing the "Swartwout" exhaust head. 3½ by 5½ in.; pp. 16.

Gasoline Engines.

Fairbanks, Morse & Co., Chicago. Catalogue devoted to a description of vertical gasoline, gas, and kerosene engines. Illustrated. 6 by 9 in.; pp. 32.

Gear Shaper.

Fellows Gear Shaper Co., Springfield, Vt.—Well-printed catalogue devoted to an illustrated description of gear shapers. 6 by 9 in.; pp. 40.

Grates.

Martin Grate Co., Chicago.—Catalogue containing an illustrated description of the Martin anti-friction rocking grate for steam boilers. 9 by 6 in.; pp. 28.

Grinding Machinery.

Builders Iron Foundry, Providence.—Catalogue, pocket size, illustrating and describing grinding and polishing machinery. Countershafts and wood polishing wheels are also given a place. 3½ by 6 in.; pp. 114.

Hoisting Engines.

Wellman-Seaver-Morgan Co., Cleveland.—Well-printed catalogue illustrating and describing hoisting engines, together with tables giving dimensions, etc. 6 by 9 in.; pp. 32.

Lathes.

Flather & Co., Inc., Nashua, N. H.—Five bulletins illustrating and describing 13, 14, 16, 18, and 20 inch lathes.

Bardons & Oliver, Cleveland.—A number of loose sheets giving dimensions of turret lathes. Oil pumps, turret oiling devices, friction countershafts, tap holders, and automatic chucks are also treated. 8½ by 11 in.

Fay & Scott, Dexter, Me.—Two catalogues describing pattern makers' and extension cap engine lathes, together with specifications. Both catalogues are well printed and handsomely illustrated. 9 by 6 in.; pp. 32.

Locomotives.

American Locomotive Co., New York.—Pamphlet containing a reprint of a paper read before the New York Railroad Club by J. E. Muhlfeld on large steam and electric locomotives. 9 by 6 in.; pp. 28.

Milling Machines.

Ingersoll Milling Machine Co., Rockford, Ill.—Catalogue devoted to an illustrated description of heavy milling machines exclusively. 6 by 9 in.; pp. 66.

Mining Machinery.

Power and Mining Machinery Co., Cudahy, Wis. Catalogue No. 6 illustrating and briefly describing machinery, furnaces and complete equipment used in roasting, smelting and refining for the recovery of precious metals. 6 by 9 in.; pp. 156.

Motors.

Allis-Chalmers Co., Milwaukee.—Bulletin No. 1052 illustrates and describes type "B" motors and generators. 8 by 10½ in.; pp. 16. Bulletin No. 1411 treats of modern rock crushing plants and contains illustrations showing recent installations. 8 by 10½ in.; pp. 48.

Riveting Machines.

John F. Allen, New York. Catalogue illustrating and describing riveting machines for structural, elevated railroad work, bridge building, and boiler making. Also contains views showing the riveter in operation. 6 by 9 in.; pp. 32.

Hanna Engineering Works, Chicago.—Catalogue No. 3 containing an illustrated description of pneumatic riveters for boiler, bridge, tank and other structural iron and steel construction. 6 by 9 in.; pp. 36.

Pumps.

Goulds Manufacturing Co., Seneca Falls, N. Y. Small booklet, well printed in two colors, illustrating and describing a small part of their complete line of power pumps. Also contains tables giving capacities and dimensions. 4 by 7½ in.; pp. 32.

Separators.

Direct Separator Co., Syracuse.—A well-printed catalogue illustrating and describing steam, oil, ammonia and boiler separators. Exhaust heads and steam traps are also given a place. 6 by 9 in.; pp. 40.

John Davis Co., Chicago.—Catalogue S containing illustrations, together with brief description, of separators for live exhaust steam and oil. 6 by 9 in.; pp. 12. Also a catalogue treating of steam specialties. 6 by 9 in.; pp. 38.

Tanks.

Flint & Walling Manufacturing Co., Kendallville, Ind.—Catalogue No. 47 illustrating and describing tanks and steel structures. Also contains views of some recent installations. 5 by 9 in.; pp. 48.

Wood Pavement.

U. S. Wood Preserving Co., New York.—"The Silent Pavement in New York" is the title of a well-printed booklet describing the advantages of this form of pavement. Also contains views showing streets on which these blocks have been laid. 8 by 6 in.; pp. 24.

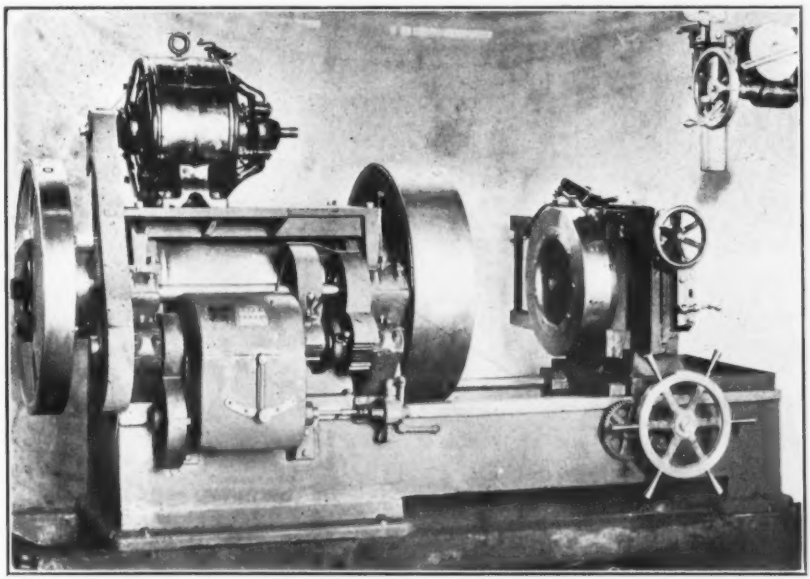
IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Twelve-inch Motor-Driven Machine.

THE photograph shows a motor-driven pipe threading and cutting machine, made by the Stoever Foundry & Mfg. Co., Myerstown, Pa. As the belt driven machine is equipped with a single belt pulley, all speeds being obtained in the gearing, there is but little difference between the belt and motor-driven types. To equip the machine for motor drive, the belt pulley is removed and a sprocket wheel for the chain put in its place. The motor table is placed above the main bearings as shown, and by the addition of the motor and the chain, the equipment is complete.



It will be readily seen that this method of motor drive has great advantages. In the first place, it renders an easy change from a belt drive to a motor drive at any time, and the motor driven machine has all the advantages of speed which are obtained in the belt driven machine, and without the extra expense and necessary waste of current which accompany the use of resistance boxes and controllers. With this design of drive, a constant speed motor is employed, which is the least in first cost and the highest in efficiency in operation. A variable speed motor could, of course, be used if anyone wished to do so, and an additional range of speeds would be secured.

The machine is of exceedingly substantial construction throughout. A departure from the older practice has been made in making the headstock in one casting, following the usual lathe construction. The gearing is all on the outside of the machine, and readily accessible for any purpose. An innovation in pipe threading machinery is the use of an internal gear drive, which is exceedingly powerful, very compact, and of course very safe, as the

teeth are carefully protected from injury.

The machine has ten speeds, the shifting gear in the gear box giving five speeds, and the right and left clutch on the machine two for each one in the box. These speeds can all be very quickly obtained, and the change is more easily made than when shifting a belt on a cone pulley, and making the additional gear change required in older machines.

The gear box is oil tight, and an arrangement is made for holding oil in the bottom, which keeps all gears and shafts constantly lubricated. Owing to the particular construction of this box, the weight of the sliding gear and shifting mechanism is carried on the brackets, and not on the lower shaft, so that there is no tendency towards cutting or binding in the box.

The chucks are of unusually strong construction. The main body of the chuck is a single casting, there being no joints or face plates to weaken the construction.

The oil for lubricating the dies is furnished by a rotary geared pump, driven direct from a constant speed shaft on the machine. There can be no slip, and there must be a positive supply of oil delivered at all times. The actual amount used on the dies and cutting-off tool is regulated by valves at the proper points, and the relief valve takes care of any excess.

The die head has been greatly improved by the substitution of interchangeable hardened steel cams for those of cast iron construction commonly used in other machines. This not only insures a much greater life and accuracy for the head, but if for any reason it should become necessary to replace a cam, it can be very easily and cheaply done. In addition to these hardened cams, hardened steel plates are placed in the bottom of the die slots. These insure a permanent bearing for the back edge of the chasers, and therefore keep the lead correct,—which is a very important point.

The sliding head has been adopted for the regular design, as it offers many advantages over the older type of stationary head. One advantage lies in convenience often secured by placing pipe in the machine through the die head, in which case the head can be pushed out of the way and the pipe pushed through the opening in the stand without injuring the dies. The greatest benefit, however, lies in the fact that the head is movable,—floating to a certain degree. There is a certain amount of eccentricity to be found in all pipe, this being materially increased in the larger sizes; consequently, a great strain is brought on the dies when used in a rigid head, but by mak ng the head movable it will adjust itself to the eccentricity of the pipe as it revolves. This not only relieves the head of unnecessary strain, but insures a more nearly equal depth of thread around the circumference of the pipe.

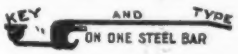
The slides for steadying the pipe while cutting off, and which are placed on the back of the stand, are unusually heavy. They are made so for what might be called an anvil effect, and will withstand the shock of hammering out a large pipe which may be too much out of round to show a perfect thread. The cutting-off and the reaming tools are held on one of these slides. The carriage is geared so that only a small amount of power is necessary to bring it up to the pipe. The bed is made of special construction to insure unusual stiffness between the headstock and the opposite end. The oil reservoir is in the bed, and a smaller supply than usual is used for necessary lubrication. It has been the endeavor to design a machine which will be simple in the arrangement of its parts, thoroughly accessible, and easily and cheaply repaired in case of accident. It has also been given great strength to withstand the severe service which a machine of this size and kind is required to give if worked to the limit of its capacity. The machine weighs complete with equipment about 10,000 lbs.

The American Typewriter.

THE American typewriter, illustrated herewith, provides a medium priced business-like machine, of the type-bar style, with all the advantages of the regular type-bar machine, and the added advantage of a saving of about 1200 small parts in the finished machine. This great saving in parts is accomplished by forging the key and the type on a single bar of steel—the key at one end and the type at the other. The type bar, therefore, is only a simple lever, entirely free from complicated mechanism,

and actually cannot get out of order. The weakness of the type bar action of typewriters is in the looseness which soon comes from the wearing of their joints. Some typewriters have as many as sixteen bearings between the key and the type, and some one of these is bound to work loose, spoil alignment and finally break down.

Of equal importance are the ball and socket bearings on which the type bars swing. This simple bearing insures free-



dom of action and minimum friction, and, consequently, light touch and high speed. The carriage and wheel escapement are mounted on ball bearings—the most approved aids to speed in typewriter construction.

The machine possesses the advantage of the insertion of special characters, such as fractions, accents, special marks, etc., in half a minute's time and changeability of carriage when that may be required. This typewriter possesses a number of other novel and exclusive features described in full in a pamphlet entitled "The American Way." The American Typewriter Co., 268½ Broadway, New York, will send it on request.

Single-Phase Railway.

THE announcement that the Washington, Baltimore & Annapolis Railway has finally adopted the single-phase system and has placed contracts for the entire electrical equipment required for this line will attract considerable interest in engineering and railway circles, not only on account of the fact that this is one of the most important orders placed for alternating current equipment in this country, but also because the original promoters of this line were the first to adopt the single-phase system. Some three years ago contracts were let for the construction of this line, but owing to financial difficulties the road was never built. It will be interesting to compare the electrical equipment proposed at that time with the present equipment which has been ordered from the General Electric Company and which represents the latest and most up-to-date practice in single-phase railway equipment. In the former plans for single-phase equipment between Baltimore and Washington it was proposed to use a trolley potential of 1,000 volts, current being delivered at this voltage at a frequency of 16⅔ cycles per second. The present contract calls for a trolley potential of 6,600 volts at a frequency of 25 cycles per second. On the cars a four-motor equipment was proposed, each motor having a capacity of 100 horse power. The new car equipments will consist of quadruple motor equipments for direct or alternating currents, each motor having a capacity of 125 horse power. While the first proposed motor equipments would have driven the cars at about forty miles per hour, the new equipments, totalling 500 horse power, will enable express trains on the road to attain a speed on tangent level track of 60 miles per hour. The details of the new road have been carefully worked out by the Roberts & Abbot Engineering Company, Cleveland, Ohio.

Some sixty miles of road will be operated by the new company. The main line will be constructed between Baltimore and Washington, with a branch line, from a point on the main line near Odenton, extending to Annapolis. Over the main line between Baltimore and Washington an express and local service will be established, express cars being operated under a fifteen minute headway and making the run in 72 minutes. The roadbed will be double-tracked throughout, with sidings arranged at suitable intervals so that the locals may be side-tracked to enable the expresses to maintain schedules. The rolling stock equipment is to be very complete. Nineteen express cars, capable of making 60 miles per hour on a tangent level track will be operated. In addition two work-cars will be equipped, each sufficiently powerful to haul a train of five ordinary passenger coaches at 45 miles per hour, while four lower-powered cars will be used for local service. These cars will each be equipped with four A. C.-D. C. motor equipments with the Sprague-General Electric type

train control. The local cars will be similarly controlled, but will be driven by two instead of four motors.

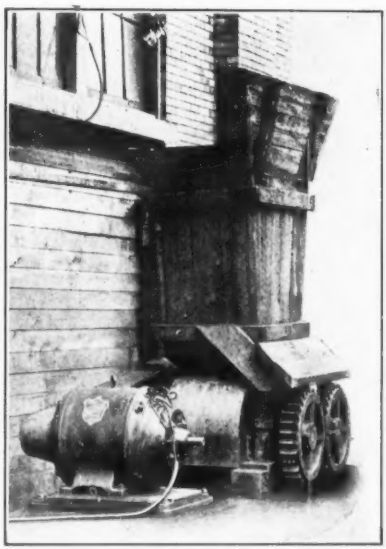
Power for the new road will be purchased from the Potomac Electric Company of Washington, D. C., and will be delivered by that company at 6,600 volts three-phase to a transformer substation about three miles from Chesapeake Junction.

At Academy Junction there will be four water-cooled transformers, 25 cycles, 800 kilowatts, reducing the single-phase 33,000 volt current of the transmission line to 6,600 volt current suitable for delivery to the cars. These transformers will supply the Baltimore and the Annapolis sections of the line. The substation at Academy Junction will be located near to the car barns. For greater safety in inspecting and handling the cars, all of the trolley circuits in the car barn will be arranged for 600 volt direct curent, and for this purpose two 300 kilowatt motor-generator sets will be installed in the transformer substation, changing the 6,600 volt alternating current to 600 volt direct current. The motor end of these motor generator sets will be connected direct to the trolley circuits, one phase being led from the trolley coming from Chesapeake Junction and the other from the Academy Junction transformers. A feeder regulator will be placed in one phase so that the motor generator sets will act as balancers, permitting the Academy Junction transformers connected on phase "B" to feed into the trolley line supplied by the Chesapeake Junction transformers on phase "A."

Government regulations within the District of Columbia prohibit the use of the track return, so that within the District the cars will be operated with a double trolley. This portion of the tracks, as well as that within the city of Baltimore, is at present operated by direct current, and the new cars are designed to operate on direct current over these sections of the line.

Motor Drive for Coal Crushing Rolls.

THE accompanying illustration shows a set of 24-inch by 30-inch Allis-Chalmers coal crushing rolls, belted to an electric motor, such as are now being installed by many users of steam driven power machinery. In connection with furnaces at which automatic stokers are used, or where for other reasons it is desirable to have the coal crushed to a uniform size, the advantages of such an arrangement will be readily apparent. The coal, as it is unloaded from the car, is passed through these rolls and drops to the hopper which feeds the stokers.



Where it is possible to secure coal in hopper cars at all times, a further improvement is made by placing the crushing rolls beneath the track, allowing the coal to drop from the car into the rolls, and falling from there to the stoker supply hopper. Motor drive is the most satisfactory for an equipment of this character, as such rolls are in operation for a limited time only each day; there is therefore no waste of power and no idle belts or extra shafting to be cared for while the rolls are not in operation. The Allis-Chalmers Company is now manufacturing a full line of these rolls, which are used not only for crushing coal, but also rock-salt, phosphate rock and other similar materials that do not require the heavy machinery furnished by this company for mining work and the crushing of harder materials. It also builds the motors by which the rolls are driven.

NEWS SUPPLEMENT

The Engineering Magazine—November, 1906

Personal.

—A. Samuel Berquist, inventor of the Berquist suspension bunker, has changed his address from 517 Bedford Ave. to 1573 47th Street, Brooklyn.

—H. S. Brown, New England sales manager of the Power Specialty Co., with offices at 10 Post Office Square, Boston, is now spending a short vacation in Europe and will return about the 15th inst.

—Louis Block, who for more than twenty years was at the head of the Engineering Department of the De La Vergne Machine Co., is now engaged as a consulting engineer with offices at 45 East 42d Street, New York. The scope of work includes specifications and plans for ice manufacturing, refrigerating and power plants, oil and gas engines, and superintendence of the installations.

Industrial Notes.

—Power Specialty Co., New York, has opened a branch office in the Land Title Building, Philadelphia, the same to be in charge of W. E. Dowd, Jr.

—The Electric Controller & Supply Co., Cleveland, announces the opening of a Chicago office in the Merchants' Loan and Trust Building, 135 Adams Street, with W. H. Connelly in charge.

—The Bristol Co., Waterbury, Conn., announce that they have opened a branch office at 753 Monadnock Block, Chicago, where they will carry a full line of recorders, together with instrument supplies.

—The Atlas Engine Works, Indianapolis, has just received an order from the United States Steel Corporation for a number of Atlas water tube boilers which are to be installed in two of the constituent companies of the Steel Trust.

—The headquarters of the gas producer department of the Morgan Construction Co. have been moved from 40 Exchange Place, New York, to Worcester, where the main office and works of the company are located. E. A. W. Jefferies will continue in charge of the department.

—In connection with the heating and ventilating equipment for the office building of the Brown & Sharpe Mfg. Co., Providence, the B. F. Sturtevant Co., Boston, will furnish 3 engine-driven steel plate fans and 3 similar fans driven by direct-connected Sturtevant motors.

—The Pennsylvania R. R. Co. are showing remarkable economies in their forge shops at Altoona. Producer gas has been installed on five furnaces and seven tons of coal are now doing the work that formerly required twenty tons. The gas producer equipment was supplied by the Morgan Construction Co., Worcester.

—Marion Steam Shovel Co., Marion, Ohio, have just received an order from the Oliver Iron Mining Co., Duluth, for twenty-nine steam shovels, for use in the different mines in the Mesabe Range in Minnesota, which they control. They have also received an order from the Republic Iron & Steel Co., for use in the same range. This is probably the largest order for steam shovels ever placed at one time.

—Universal Portland Cement Co., a subsidiary company of the United States Steel Corporation, have taken over the plants and business of the Cement Department of the Illinois Steel Co., and will continue the manufacture of universal Portland cement as heretofore. The new company will be under the management of the same persons who have had charge of the Cement Department of the Illinois Steel Co.

—The Somerset Coal Co., Baltimore, Md., recently ordered for installation at the Jenner Mines, Boswell, Pa., two Allis-Chalmers heavy duty, cross compound engines for direct connection to 300 K.W. alternating current generators. The new units, which are being furnished by the Allis-Chalmers Co., Milwaukee, will be operated at a speed of 150 revolutions per

minute, condensing under a steam pressure of 150 pounds.

—The increasing use of the direct-connect electric fans of various types and sizes is manifest in the increasing orders received by the B. F. Sturtevant Co., Boston, among which the following have been reported: Solvay Process Co., Syracuse; Julius Kayser & Co., Brooklyn; Geerin Bros. Co., Cincinnati; S. Pearson & Son, Inc., Long Island City; Empire Machine Co., Pittsburg; T. Eaton & Co., Toronto; United Shoe Machinery Co., Boston, and Tuttle & Bailey Mfg. Co., Brooklyn.

—Morgan Construction Co., Worcester, announce that they have closed a contract with the Illinois Steel Co., for 140 gas producers with gas flues and Dyblie reversing valves to operate the 28 open hearth furnaces to be erected at Gary, Ind. This is the largest contract for gas producers that has ever been given. This company has also obtained a remarkable recognition of the merits of their work in England and Europe, where about one hundred Morgan continuous gas producers have been sold during the past twelve months.

—The Sioux Falls Electric Light & Power Co., Sioux Falls, recently purchased a 14 inch by 24 inch Reynolds reliance Corliss engine, built by the Allis-Chalmers Co., Milwaukee. The new unit, which is being furnished without shaft, fly-wheel or outer bearing, will be used to make up one side of a twin engine, the other side of which was purchased over a year ago from the same builder. The completed unit will be carried in reserve, as the present power facilities used by the Sioux Falls Co. comprise water turbines. The unit will be operated at a speed of 150 revolutions per minute, non-condensing, under a steam pressure of 130 pounds and belted to a shaft for operating an electric generator.

—Albert Oliver, manager of the fireproofing department of the Clinton Wire Cloth Company, Clinton, Mass., has moved from 150 Nassau Street to more commodious quarters in the Metropolitan Building, 1 Madison Ave. The scope of the Clinton products is shown by the following, representing a few of the important structures in which they have been used throughout: Electric power house of the New York Central Railroad, Yonkers; plant of the St. Croix Paper Co., Sprague Falls, Me.; Hamburger Building, Sonneborn Building, Baltimore; City Hall, Newark; plant of the American Can Co., plant of the Merchants' Refrigerating Co., Hermitage Building, Tichenor-Grand Co's stable, Bliss residence, addition to the Long Acre Hotel, N. Y.; U. S. Naval Coaling Station, Sangley Point; Cavité, P. I.; Harbor Freight Sheds, Montreal; new plant of the Singer Mfg. Co., St. Johns, Quebec; Wells-Fargo Building, Portland, Oregon, and the Fairmount Hotel, San Francisco.

—The twin tunnels of the Hudson Company, connecting Jersey City with New York under the North River, represent the most recent development in electrical projects centering about New York City. Construction work on these tunnels was finished about a year ago and work on the electrification will begin at once. Fifty electric cars will be operated, taking their power from the third-rail. Each tunnel will have a single track; the north tube carrying the west bound traffic and the south tube carrying the east bound or New York traffic. The cars will be operated in trains by the Sprague-General Electric system of multiple unit control in a manner similar to that employed on the New York subway trains. Each car will be equipped with two GE-76 (160 HP) railway motors. Power for this new development will be supplied from a large station on the New Jersey side. Curtis steam turbines will be employed: initial equipments including 2-3000 Kw., 11,000 volt machines and 2-6000 Kw., 11,000 volt machines. The total power so generated will be distributed at high voltage to three sub-stations where the alternating current will be stepped down to 650 volts direct current through transformers and rotary converters. It is expected that when the new line is in operation, the running time between the various suburban cities of New Jersey and New York City will be reduced one-half. The General Electric Co. will furnish the complete electrical equipment.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

BURY COMPRESSOR CO., Erie, Pa.—Bulletins Nos. 30 and 32 illustrating and describing air compressors and vacuum pumps, steam, belt and motor driven. 6 by 9 in.; pp. 20.

Ball Bearings.

CHAPMAN DOUBLE BALL BEARING CO. OF AMERICA., New York.—Catalogue illustrating and describing ball bearings. Also contains many testimonial letters from users. 6 by 9 in.; pp. 44.

Bolts and Nuts.

AMERICAN IRON & STEEL MFG. CO., Lebanon, Pa.—Catalogue and price list of bolts, nuts, studs, cap screws, rivets, turnbuckles, etc. Illustrated. 6 by 9 in.; pp. 116.

Bolt and Nut Machinery.

ACME MACHINERY CO., Cleveland.—Catalogue illustrating and describing bolt cutters, nut tappers, bolt heading, rivet heading, upsetting and forging machines, together with price list. 9 by 6 in.; pp. 144.

Coal Crushers.

PENNSYLVANIA CRUSHER CO., Philadelphia.—Two circulars containing an illustrated description of coal and coke crushers, together with tables giving speed, capacity, weight, etc.

Chucks.

E. HORTON & SON CO., Windsor Locks, Conn.—Catalogue illustrating and describing lathe and drill chucks, together with tables giving dimensions. 5 by 7 in.; pp. 120.

HOGGSON & PETTIS MFG. CO., New Haven, Conn.—Catalogue No. 7 illustrating and describing the Sweetland chuck, together with tables giving dimensions and prices. 4¾ by 7 in.; pp. 54.

Drills.

FOSDICK MACHINE TOOL CO., Cincinnati.—Catalogue illustrating and describing radial drills and horizontal boring, drilling and milling machines. 6 by 9 in.; pp. 56.

B. F. BARNES CO., Rockford, Ill.—Catalogue devoted to an illustrated description of upright and gang drills, lathes, tool grinders and key seaters. The catalogue is well printed. 6 by 9 in.; pp. 80.

Drill Presses.

WILLIAM GARDAM & SON., N. Y.—Catalogue giving the size, capacity, general dimensions and construction of sensitive drill presses manufactured by this company. 4 by 8 in.; pp. 26.

Electric Equipment.

GENERAL ELECTRIC CO., Schenectady,.—Bulletins Nos. 4451, 2, 3, 4, and 5, illustrating and describing incandescent lamps, arc lamps, "Gem" meridian units, railway motors, and single-phase motors respectively.

Emery Wheels.

ABRASIVE MATERIAL CO., Philadelphia.—Illustrated catalogue describing emery and carborundum wheels. Also contains price list giving sizes. 6 by 9 in.; pp. 52.

Feed Water Purifiers.

F. E. KEYES & SON., N. Y.—Folder illustrating and describing feed water purifiers. Also contains information of value to engineers. 4 by 9½ in.; pp. 4.

Flexible Roller Bearings.

HYATT ROLLER BEARING CO., Harrison, N. J.—Bulletin illustrating and describing flexible roller bearings as applied to transmission of power and heavy duty at slow speed. 6½ by 8½ in.; pp. 80.

Furnaces.

WELLMAN-SEAVER-MORGAN CO., Cleveland.—Well-printed pamphlet illustrating and describing open hearth and re-heating furnaces. Also contains views showing recent installations. 9 by 12 in.; pp. 48.

Gas Engines.

WITTE IRON WORKS CO., Kansas City.—Catalogue illustrating and describing gas, gasoline and distillate engines. 9 by 6 in.; pp. 40.

Generating Sets.

B. F. STURTEVANT CO., Boston.—Bulletin No. 139 presents a full line of generating sets driven by direct-connected vertical enclosed engines with forced lubrication. The list contains 14 sizes ranging from 3 to 50 K.W. in output. Catalogue No. 140 treats of high pressure blowers. The catalogue is well printed and handsomely illustrated. 6¾ by 9 in.; pp. 48.

Grinding Machines.

BATH GRINDER CO., Fitchburg, Mass.—Illustrative and descriptive catalogue of plain and universal grinding machines. 6 by 9 in.; pp. 40.

Lathes.

FOSTER-KIMBALL MACHINE CO., Elkhart, Ind.—Loose-leaf catalogue containing illustrations, together with brief descriptions, of turret lathes. 9 by 11½ in.

HENDEY MACHINE CO., Torrington, Conn.—Catalogue containing an illustrated description of engine lathes. 9 by 6 in.; pp. 96. Also a catalogue illustrating and describing milling machines. 6 by 9 in.; pp. 64.

Machine Tools.

GOODELL-PRATT CO., Greenfield, Mass.—Catalogue No. 7, pocket size, giving an illustrated description of machine tools, together with sizes and prices. 3½ by 5½ in.; pp. 176.

Metal Grinding Machinery.

IROQUOIS MACHINE CO., New York.—Catalogue treating of the many different styles of metal grinding machinery manufactured by this company. Illustrated. 6 by 9 in.; pp. 64.

Metal Sawing Machinery.

COCHRANE-BLY CO., Rochester.—Catalogue, together with a number of loose sheets, illustrating and describing metal sawing machines. 9 by 6 in.; pp. 12.

Oil Filters.

BURT MANUFACTURING CO., Akron, O.—Well-printed catalogue containing an illustrated description of oil filters. Also contains a partial list of users. 6 by 9 in.; pp. 48. Also a small pamphlet devoted to the Burt combination skylight and ventilator.

Pneumatic Tools.

INDEPENDENT PNEUMATIC TOOL CO., Chicago.—Circular No. 6 illustrates and describes pneumatic hammers, drills, wood-boring machines, etc. 8¾ by 11¾ in.; pp. 8.

Polishing Wheels.

DIVINE BROS. CO., Utica, N. Y.—Small pamphlet illustrating compress polishing wheels and describes how they are made, what they do and how they do it. 3½ by 6 in.; pp. 18.

Presses.

E. W. BLISS CO., Brooklyn.—Catalogue, bound in cloth, illustrating and describing presses, dies and special machinery, together with tables giving dimensions, prices, etc. 5 by 7½ in.; pp. 578.

Propeller Fans.

MASSACHUSETTS FAN CO., Waltham, Mass.—Sectional catalogue No. 50 illustrating and describing Davidson propeller fans, together with many tables containing much useful data. 7 by 9½ in.; pp. 32.

Shapers.

GOULD & EBERHARDT, Newark.—Catalogue C illustrating and describing shapers and attachments. Also contains tables giving dimensions. 9 by 6 in.; pp. 50.

Slotters.

T. C. DILL MACHINE CO., INC., Philadelphia.—Catalogue illustrating and describing slotters, together with tables giving principal dimensions. 9 by 6 in.; pp. 20.

Steam Engines.

FRANK TOOMEY, Philadelphia.—Catalogue containing an illustrated description of Troy automatic engines. 9 by 6 in.; pp. 40.

CHANDLER & TAYLOR CO., Indianapolis.—Catalogue illustrating and describing self-oiled, direct connected engines. Water tube boilers are also treated. 6 by 9 in.

FILER & STOWELL CO., Milwaukee.—Catalogue giving a brief illustrated description of Corliss engines. Also contains many views showing recent installations. 9 by 6 in.; pp. 128.

Steam Traps.

E. M. NICHOLAS, Philadelphia.—Booklet illustrating and describing the value and use of steam traps, and contains much important information. 3½ by 6 in.; pp. 16.

Steel Piling.

UNITED STATES STEEL PILING CO., Chicago.—Pamphlet briefly describing the advantages of steel sheet piling. Also contains many views of buildings on which this piling has been employed. 5½ by 8½.; pp. 24.

Taps and Dies.

J. M. CARPENTER TAP & DIE CO., Pawtucket, R. I.—Catalogue, pocket size, treating of taps, dies, screw plates, die stocks, tap wrenches, etc. Also contains tables giving sizes, prices, etc. 3½ by 6 in.; pp. 158.

Threading Machinery.

DETRICH & HARVEY MACHINE CO., Baltimore.—Catalogue containing an illustrated description of threading and tapping machinery. 9 by 6 in.; pp. 58.

Traveling Cranes.

FREVERT MACHINERY CO., N. Y.—Two circulars illustrating and describing hand-power traveling cranes and trolleys.

Tumbling Barrels.

GLOBE MACHINE & STAMPING CO., Cleveland.—Booklet devoted to an illustrated description of tilting tumbling barrels. 3½ by 6 in.; pp. 12.

Vises.

HOLLANDS MFG. CO., Erie.—Catalogue A is a price list of vises, and machinists' and plumbers' tools. Illustrated. 4½ by 6 in.; pp. 54.

Water Wheel Governors.

THE PICKERING CO., Portland, Conn.—Catalogue illustrating and describing water wheel governors, together with tables giving sizes, dimensions, prices, etc. 9 by 6 in.; pp. 22.

Wrenches.

BULLARD AUTOMATIC WRENCH CO., Providence.—Catalogue containing an illustrated description of the Bullard automatic wrench. 8 by 5 in.; pp. 24.

COES WRENCH CO., Worcester.—Catalogue containing a brief illustrated description of screw wrenches. Also contains price list. 6 by 9 in.; pp. 16.

IMPROVED MACHINERY

New Processes and Appliances

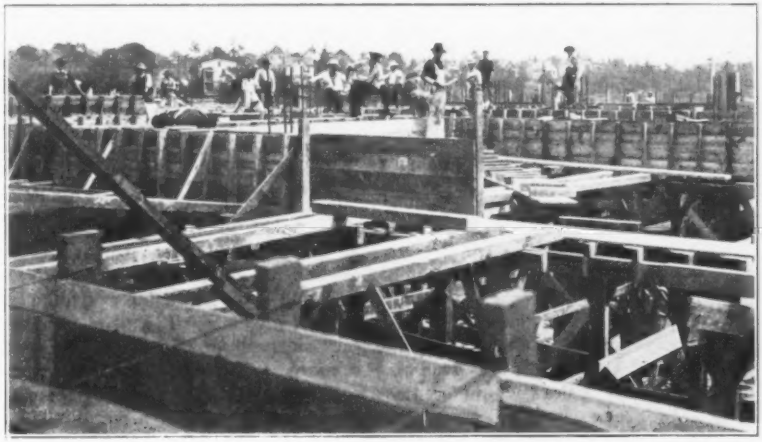
The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Reinforced Concrete Buildings for a Paper Mill.

THERE has just been completed at Bogota, N. J., a group of large buildings for the Traders' Paper Board Co., in which reinforced concrete was adopted to secure abundant light and to provide large floor surfaces. They are proportioned for heavy floor loads and in some cases to support machinery and impact. This type of construction was selected in competition with steel, masonry, and wooden construction because it is absolutely fireproof and requires little or no expense for maintenance.

The principal buildings include an 84 x 212-ft. three-story beater house 45 ft. in height to the eaves; two 96 x 80-ft. one-story screen rooms, 18½ ft. high to the eaves, an 800 x 256-ft. one-story machine building 21 ft. high to the eaves, and several smaller buildings. The second floor in the beater house is designed for a live load of 400 lb. per square foot, including the machines installed there, and the third floor of the same building is designed for a 200-lb. live load. The roofs are all designed for a live load of 40 lb. per square foot. The first floors consist of 6 in. of concrete laid on solid earth fill. All roofs have a pitch of about 1:12 from the longitudinal center line and are supported by the exterior walls and by three longitudinal rows of columns except in the machinery building, where there is only a single center row of columns and the transverse roof girders attain a maximum span of 40 ft. The maximum span of the floor girders is 20 ft. and the columns are generally arranged 8 ft. or 16 ft. apart.

In the one-story building the side walls, as shown in the machinery building, are merely curtains of solid concrete 6 in. thick and 4 ft. high made without reinforcement. The spaces above them to a considerable height are filled with a line of windows that occupy about 70 per cent. of the total wall space. In the three-story building there are narrow belts of exterior wall just above and below the upper floor lines and the remainder of the wall space is occupied by windows with sliding sash. The wall columns have rectangular cross-sections made integral with the walls and are flush



FALSE-WORK AND FORMS FOR FLOOR GIRDERS, DESIGNED TO CARRY 400 POUNDS PER SQUARE FOOT.

with their inner surfaces so as to form exterior buttresses.

The interior columns have circular cross-sections and, like the exterior ones, are made integral with the roof and floor girders and are connected to them by corbels forming solid-web knee-braces of the full width of the girders and continuous with them. Besides the crane girders and the shaft brackets, both of reinforced concrete, there are few structural features in the building except the columns, floors and roof. The details involved special design on account of the necessity of providing for a large amount of machinery in the beater house which made the construction extremely irregular, so that floorbeams and girders, panel lengths and other elements of the construction lack uniformity.

All columns have offset piers of concrete without reinforcement, carried down in open pits to footings on the hard clay at a depth of about 6 ft. below the original surface. The interior columns were all made in position, with forms of expanded metal wired together to form cylinders anchored to the piers and lined with expanded metal lath, and filled with concrete reinforced by four full-length vertical rods wired to the inside of the expanded metal at equidistant points. After the form was filled the exterior of the column was finished with a 1-in. coat of cement plaster applied with a trowel. The upper parts of the columns were made in special wooden forms connecting the expanded metal with the forms for the floor and roof girders and providing for the corbels or kneebraces which connect the columns and girders. The wall columns were also reinforced with four full-length vertical rods, one in each corner, and were made simultaneously with the walls in ordinary wooden forms.

The machine building, 80 ft. wide, is divided into two aisles by the center longitudinal row of columns which supports the roof and the runway girders of the traveling cranes, which are of 30,000-lb. capacity and 39-ft. span. These girders are integral with the columns and their corbels, and are connected in the planes of their upper surface by a continuous horizontal slab 4 in. thick and 3 ft. wide, forming part of the girder cross-section. They are reinforced by three 1-in. tension bars in the bottom of each girder and by one ½-in. bar in the upper outside corner of each girder. Cast-iron chairs are bedded in the concrete and bolted to it to receive the girder rails.

The corresponding wall girders for the same cranes are of irregular outline and practically consist simply of offsets on the interior face of the wall sufficient to provide seats for the girder rails and to distribute the load to the wall itself. The entire cross-section of the latter, from the window openings to the eaves, acts as a girder about 9 ft. deep. It is reinforced by a pair of 1-in. bars directly under the rail, by a ¾-in. bar over the windows and by another one between the rail and roof girders. Concrete brackets 45 in. wide project from the lower columns just below the runway girders to carry lines of shafting. They are uniformly 10 in. thick and are reinforced by two sets of five horizontal ½-in. bars that extend through the thickness of the column in two vertical planes about 2½ in. inside of the center.

The tops of the center columns 16 ft apart are connected by a ridge girder 36 in. deep and 12 in. wide, reinforced by three 1¼-in. bottom flange tension rods. These girders support at their center points intermediate rafters 21 in. deep and 10 in. in minimum thickness, with six 1¼-in. bottom flange reinforcement bars in each. Like all other beams and girders, their total depth includes the thickness of the floor or roof slab, which in this case is 3 in. and is calculated to act as a part of the girder for short distances beyond the latter. The sides of all girders are slightly tapered to facilitate the removal of the forms and in this case are 12 in. apart at the top and 10 in. at the bottom, giving a batter of about 1:18 on each side. Shear is provided for by short reinforcement rods in the kneebraces or corbel brackets and by bending the ends of the bottom flange bars upwards. The bars are made of different lengths and are arranged so that successive bars terminate at different distances from the center of the girder and provide inclined web members at several points determined by the shear diagram, as shown in the elevation of the girder. The roof slab is in this case supported entirely by the rafters without longitudinal joists or purlins and is rein-

forced with a single tier of ½-in. longitudinal rods 12 in. apart on centers.

In the screen room, the general construction corresponds with that in the machine building, except that there are three lines of longitudinal columns dividing the building into four aisles and the dimensions of the columns and girders vary with the loading. There are runways for five-ton girder cranes of 39-ft. span in the two center aisles. Those supported by the center columns are like those in the machine building, but those carried by the side columns are of special construction conforming to their eccentric connections with the square columns. They are normally 12 in. wide and 26 in. deep above the tops of the corbels and are reinforced with four 1-in. bottom flange bars.

In one place two intermediate columns are omitted, necessitating a runway girder span of 24 ft., which also carries the shaft brackets and receives from them a considerable twisting stress. Provision for this is made by making the regular section of the girder integral with an unsymmetrical lower section of the full depth, 4 ft., of the bracket, thus affording a total depth of about 7 ft. for the girder and providing full depth connections for the brackets. This extension of the girder is 18 in. wide to correspond with the thickness of the column and the top and bottom flanges are 14 in. deep. The peculiarity of construction consists in locating the 6-in. web eccentrically, so that its face is in the plane of the column face and intersects with the brackets there. This gives an unsymmetrical disposition of material in the flanges and allows three of the six 1¼-in. steel tension bars to be placed at the greatest distance from the neutral axis so as to resist most effectively the twisting stress from the bracket.

The 61 x 136-ft. one-story boiler house is unsymmetrically arranged with a single row of longitudinal columns 30 ft. high and 36 ft. on centers from the rear wall so as to provide room for the boilers on that side of the building while the narrower aisle on the other side serves for a passageway in front of the boiler doors and contains a full-length coal bin about 10 ft. wide, with its long walls connected by 1-in. tie rods from 4 to 5 ft. apart vertically. The walls of this bin are continued above the main roof of the building to enclose a gallery in which there is a small coal bin filled by a conveyor plant and discharging through bottom valves into automatic cars running over the roof of the building. The contents of the main bin are discharged through gates near the bottom and the

BOILER-HOUSE.

space below these gates is permanently filled with coal, which serves as an emergency reserve and can be shoveled out if necessary. As the clearance between the coal bin and the boiler front is not sufficient to permit the removal of the boiler tubes, a 3 x 5-ft. rectangular horizontal reinforced concrete chamber is carried through the coal bin on the center line of each boiler front and is provided with doors at both ends which can be opened to permit handling the tubes when necessary, thus affording an unobstructed passage through the coal bin.

In the main building numerous piers are located on the lower floor to provide foundations for the machinery. These are essentially concrete walls and piers, generally made without reinforcement. They are arranged to clear a 7½ x 40-ft. cistern 10 ft. deep, with side walls 8 in. thick, reinforced by ½-in. vertical bars 6 in. apart on centers and ½-in. horizontal bars 2 ft. apart on centers. The bottom is similarly reinforced with bars in both directions. The interior of the cistern is waterproofed by a 1-in. coat of 1:1 cement mortar and the top is covered by a floor slab 5 in. thick with transverse ½-in. reinforcement bars 8 in. apart.

Adjacent to the cistern an L-shaped concrete drain crosses through the center of

the building and along one end. It is a rectangular open conduit 5 ft. wide and 4 ft. deep outside and 3 ft. wide and 34 in. deep inside, with rounded corners. It is made without reinforcement and the top is covered with movable reinforced concrete slabs 3 in. thick and 44 in. wide. This drain receives the waste water from the buildings and the rainwater from the roof. The latter flows from the ridge both ways to the eaves where it is intersected by vertical concrete flash boards about 6 in. in height which form a sort of parapet on the inclined roof surface just above the eaves. The parapet is divided into lengths corresponding to two panels of rafters. In the middle of each panel there is a leader close to the eaves line. The parapet extends from this leader to a point about a foot nearer the center of the roof in the middle of each adjacent panel, where it intersects the corresponding parapet from the next leader, thus forming a zigzag line along the edge of the roof that diverts the water both ways to the leader and gives a pitch providing complete drainage of the roof without giving any further longitudinal inclination to the gutter than is furnished by the regular transverse pitch.

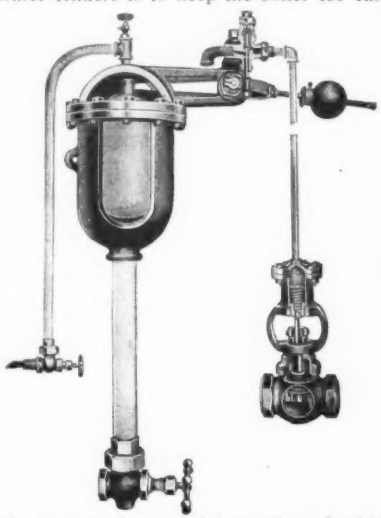
All concrete was made 1:2½:5 with Portland cement furnished by the Pennsylvania Cement Co., and screened broken stone from ¾ to 1 in. in diameter. All reinforcement is made with Johnson corrugated bars proportioned for unit stress of 16,000 lb. Concrete is figured to carry a compressive stress of 600 lb. Broken stone and sand were delivered on railroad cars and shoveled into elevated bins alongside the track, the materials afterwards being shoveled out as required for construction. Concrete was mixed in three Ransome machines, and from them was delivered by wheelbarrows to the elevators, raised to the required height, wheeled over the forms and dumped as required.

Owing to the great irregularity previously mentioned in the size and location of the beams and girders, it was impossible to make the forms in duplicate and they were built as required without the use of interchangeable or knockdown panels. The side pieces of the girder forms were connected to the bottom piers with triangular filler blocks in the angles to chamfer the corners of the girders in all cases. Above these blocks they were tied together with double twisted wires 4 ft. apart on centers which served to support the reinforcement bars. When the molds were stripped, the projecting ends of the wires were cut off, leaving the interior portion permanently imbedded. The column forms were filled from the top with concrete wheeled over the falsework and floor molds. Concrete was mixed very wet and care was taken to flush the mortar to the top in the floor slabs which were finished with checkered rollers.

Work was commenced in November, 1905, and has just been completed, the process being considerably impeded by the irregularity of construction and the necessity of conforming to changing plans for the machinery. The Curtin-Ruggles Co. of New York City, designed and supervised the work.

Feed Water Regulation.

STEAM boilers are designed to work most economically when the water is at the middle gauge, for at this point there is the maximum heating surface and the maximum steam space. The tendency of all water tenders is to keep the boiler too full

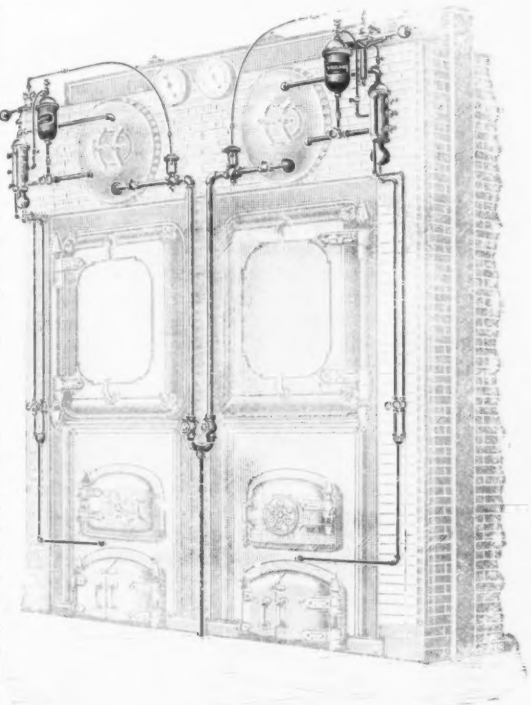


of water, as they are then on the safe side. If a boiler is filled in three gauges, not only is the temperature of the boiler lowered, but

the extra gauge of water is above the point of contact with the heat in the fuel which must be consumed to convert it into steam is wasted. When the water level is kept uniformly at the proper point, the heat is constantly applied to the same amount of water at the same temperature. A further saving of fuel is obtained when the water is fed through the heater or economizer at a slow and uniform rate, for then the feed-water is heated to a higher degree than is possible when the flow varies, as is always the case with hand feeding. A properly designed boiler will not prime or flood the steam pipes, if the water level is kept at the middle gauge. Nearly all of the cases of boilers priming and water in the engine cylinders are due to carelessness of the attendant in allowing the boilers to get too full of water. This causes great loss in cylinder lubrication, to say nothing of scored cylinder head, or the cylinder itself. Modern steam engines are now built with so little clearance that this danger is much greater than formerly.

Strains of expansion and contraction are inseparable from hand feeding of boilers. Boilers are chilled by changing water levels and temperatures; caused by suddenly feeding large quantities of water, even from a heater of 200 degrees. There is about as much difference in temperature between hot feed water at 200 degrees, and the temperature of a boiler at 125 pounds pressure, as there is between ice water and boiling water. To overcome the disadvantages of hand feeding and meet the ideal conditions of the water level constantly maintained at a given point, L. B. Fulton, of the Chaplin-Fulton Mfg. Co., invented about 1895 the Vigilant automatic boiler feed.

The cuts show a sectional view of the Vigilant feed water regulator and the same applied to a modern water tube boiler. The machine is attached to water column. The regulator consists essentially of three parts. The first is a special brass nipple and gate valve combined, which is screwed into the water column at the point it is desired to carry the water level. From this a three-eights inch pipe connection is made to the top of the chamber of the regulator. The second part of the apparatus is a hooded chamber, as shown. A one-and-a-fourth connection is made from the bottom of the chamber to the boiler, or to the bottom connection of the water column. Inside the chamber is suspended a weight, which is hung from the end of a lever, whose fulcrum is a shaft, one end of which extends



through a stuffing box, while the other rests on a step inside. To the protruding end of this shaft is keyed another lever which carries an adjustable counterweight, and at the fulcrum has a shoe with an adjustable set screw for lifting the stem of the actuating valve. This valve is attached to the top of the hood, and a steam connection made to the gauge pipe or other point where dry steam may be obtained. The valve has an upper and lower bearing so arranged that when against the upper seat the steam

connection is closed and the bottom one is open to the atmosphere. When seated on the bottom seat the connection to the air is closed and the steam pressure is admitted to the controlling valve. The controlling valve is the third part of the regulator and is placed in the feed line to the boiler. In construction it is similar to a check valve, and the entering water tends to lift the valve. A stem extends from the valve through a stuffing box to a hood which has a mushroom top, on which rests a piston Under the mushroom is a spring which tends to open the valve when there is no pressure on the piston.

When the water level is below the opening of the special nipple the regulator chamber will be full of steam, and the water in the pipe to the chamber will be the same height as in the column. The weight in the chamber is then heavier than the counterweight, and the latter will be in the top position and the actuating valve held against its top seat, and the exhaust will be open to the air. There can then be no pressure on the diaphragm, and the controlling valve will be wide and the boiler taking water. When the boiler fills up to the opening of the special nipple the steam will be cut off from entering the chamber, and the steam which was in it condenses and forms a partial vacuum so that the water from the boiler instantly fills it to the top. The inside weight then weighs less than it did when it hung in steam, by the weight of the water which it displaces. The counterweight is now heavy enough to overbalance the inside weight goes up. As the outside lever goes down the actuating valve goes down, opening the steam connection and shutting the exhaust. This admits the steam pressure to the diaphragm chamber and forces the controlling valve down, so that the feed water is shut off at once. No more water can enter the boiler until the water level falls, when all the operations are reversed and the controlling valve opens again. These operations are repeated as the water gets above or below the desired point, and the variation does not exceed one-half inch.

Full details of the working of the Vigilant feed-water regulator in actual practice will be sent on request to the Chaplin-Fulton Mfg. Co., Pittsburg, Pa.

Valuable Suggestions Contained in Patents.

OVER 30,000 patents are issued each year by the Patent Office at Washington. In this large number of patents all branches of invention are represented, some of the more active lines by from 500 to 800 patents yearly. From 23,000 to 25,000 U. S. patents expire each year, and the inventions they cover thereby are opened to the free use of the public. Every manufacturer of patented machinery is interested in knowing what these new and expiring patents cover, in so far as they relate to inventions similar to those in his own line of manufacture. He is interested in knowing who owns such new patents, what among them belong to his competitors, how the new inventions affect his own lines, and what improvements can be devised in order to keep his own product up-to-date. They show where other people have patented devices or machines, the manufacture of which would infringe his own patents, possibly enabling him to "nip in the bud" such infringement. Expiring patents show the manufacturer what patented inventions he will be at liberty to adopt upon the expiration of the patents. As is well known, many inventions were produced far ahead of their times,—for example, the cord knotter for grain binders, the pneumatic tire, and many others; furthermore, many valuable patents are not exploited, but lie dormant throughout their terms. Many profitable "side lines" and probably greater opportunities lie among these unexploited inventions.

Manufacturers realize the importance of the information outlined, and some of the large companies have patent departments for obtaining it for the benefit of their administrative, mechanical, and inventive departments, but the great majority have had no practicable way in which to obtain the desired information. Luther L. Miller, a Chicago patent attorney, has established a department of his patent law practice for supplying to manufacturers such general information as they require with relation to current or expired patents. In organizing this department Mr. Miller has adopted, as far as practicable, the methods of the large concerns, with reference to their patent departments, and will furnish information about it to those who may inquire.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Brakes.

ALLIS-CHALMERS CO., Milwaukee.—Bulletin No. 1508, devoted to an illustrated description of Christensen straight air brake equipment. 8 by 10½ in.; pp. 12.

Air Compressors.

BURY COMPRESSOR CO., Erie.—Bulletins Nos. 30 and 32 illustrating and describing air compressors and vacuum pumps. 6 by 9 in.; pp. 24.

CHICAGO PNEUMATIC TOOL CO., Chicago.—Catalogue No. 20 is devoted exclusively to a detailed description of air compressors. Also contains numerous tables and formulas. The catalogue is well printed and illustrated. 6 by 9 in.; pp. 116.

Arch Bridges.

CONCRETE-STEEL ENGINEERING CO., New York.—Booklet showing many concrete-steel arch bridges erected by this company. Also a pamphlet treating of Thacher bars for concrete-steel construction. 6 by 9 in.; pp. 16.

Asphalt Roofing.

WARREN CHEMICAL & MFG. CO., New York.—Catalogue briefly describing the advantages of asphalt roofing. Also contains testimonial letters from users and views of buildings on which this roofing has been employed. 6 by 9 in.; pp. 28.

Belting.

BUFFALO WEAVING AND BELTING CO., Buffalo.—Well-printed catalogue describing cotton and rubber filled and covered belting. Also contains a price list. 6 by 9 in.; pp. 24.

Blast Furnaces.

RISDEN IRON WORKS, San Francisco.—Bulletins Nos. 19-1 and 19-2 treating of silver-lead and copper blast furnaces respectively.

Blue Printing Machines.

BUCKEYE ENGINE CO., Salem, Ohio.—Catalogue containing a brief description, together with illustrations, of electric blue printing machines. 4 by 9 in.; pp. 16.

Cement.

CHARLES WARNER CO., Philadelphia.—Catalogue containing a list of recent users of this cement, together with a number of views showing bridges, buildings, docks, etc., on which it was used. 9 by 6 in.; pp. 24.

UNIVERSAL PORTLAND CEMENT CO., Chicago.—Catalogue containing many illustrations of bridges, buildings, etc., on which this cement has been used. 6 by 9 in.; pp. 62. Also a pamphlet entitled "The Process of Concreting," being a reprint from Concrete, Plain and Reinforced, by Taylor and Thompson. 6 by 9 in.; pp. 22.

Clocks.

E. HOWARD CLOCK CO., Boston.—Three catalogues illustrating and describing tower, hall, office and bank clocks, regulators, and electric watchman's clocks.

Coal Mining Machinery.

GEO. D. WHITCOMB CO., Chicago.—Catalogue entitled "Mechanical Methods of Mining," containing an illustrated description of coal mining machinery, together with tables giving dimensions. 6 by 9 in.; pp. 96.

Compound Engines.

B. F. STURTEVANT CO., Boston.—Bulletin No. 141 illustrates and describes vertical compound engines of class VC 6. 6¼ by 9 in.; pp. 8. Bulletin No. 142 treats of generating sets with compound engines. 6½ by 9 in.; pp. 8.

Concrete Block Machines.

IDEAL CONCRETE MACHINERY CO., South Bend, Ind.—Catalogue describing hollow concrete building block machines. Also contains many illustrations showing houses built of blocks made by this machine. 11 by 8 in.; pp. 24.

Concrete Mixer.

BUFFALO CONCRETE MIXER CO., Buffalo.—Illustrated catalogue describing automatic concrete mixers. Contains numerous testimonials from users. 6 by 9 in.; pp. 12.

Concrete Construction.

ABERTHAW CONSTRUCTION CO., Boston.—A well-illustrated catalogue describing reinforced concrete as used in manufacturing plants. 6 by 9 in.; pp. 32. Also a pamphlet treating concrete-steel arch bridges. 8 by 6 in.; pp. 40.

Concrete Curb.

STEEL PROTECTED CONCRETE CO., Philadelphia.—Pamphlets illustrating and describing steel-bound concrete curbs.

Cooling Towers.

DE LA VERGNE MACHINE CO., New York.—Folder describing the Klein water cooling tower. Illustrated. 6 by 9 in.; pp. 4.

Cranes.

WHITING FOUNDRY EQUIPMENT CO., Harvey, Ill.—Bulletin No. 45 illustrating and describing electric cranes for foundries, machine shops, power stations, etc. 6 by 9 in.

Drills.

SULLIVAN MACHINERY CO., Chicago.—Bulletin 51-D devoted to an illustrated description of pneumatic hammer drills for quarrying and contracting work. 6 by 9 in.; pp. 12.

INGERSOLL-RAND CO., New York.—Bulletin No. 2011, issued by their pneumatic tool depart-

ment, illustrating and describing the "Little Jap" hammer drill. 6 by 9 in.; pp. 20.

Feed Water Regulator.

CHAPLIN-FULTON MFG. CO., Pittsburgh.—Catalogue illustrating and describing feed water regulators and other steam specialties, together with tables giving capacities and prices. 6 by 9 in.; pp. 48.

Flexible Shaft.

STOW MANUFACTURING CO., Binghamton.—Catalogue illustrating and describing flexible shaft for all purposes. 6 by 9 in.; pp. 80. Also a pamphlet describing and showing various applications of multi-speed motors. 7 by 10 in.; pp. 32.

Hoisting Machinery.

J. G. SPEIDEL, Reading.—Catalogue illustrating and describing hand power hoisting machinery. 6 by 9 in.; pp. 24.

CHASE MACHINE CO., Cleveland.—Catalogue illustrating and describing hoisting engines, docking and winding engines, hauling engines, and steam hoists for all purposes. 6 by 8½ in.

Industrial Railroads.

ERNST WIENER CO., New York.—Small booklet illustrating and describing railway materials for all industries. 3½ by 6 in.; pp. 16.

Lockers.

NARRAGANSETT MACHINE CO., Providence.—Catalogue G4 illustrating and describing steel and wood lockers, together with lists of stock sizes and description of parts, locks, benches and other accessories. 6 by 9 in.; pp. 32.

Locomotives.

AMERICAN LOCOMOTIVE CO., New York.—Catalogue illustrating and describing consolidation type freight locomotives weighing less than 175,000 pounds. 9 by 6 in.; pp. 72.

Manganese Steel.

TAYLOR IRON & STEEL CO., High Bridge, N. J.—Catalogue A containing a description of manganese steel, special steels and steel castings. Illustrated. 6 by 9 in.; pp. 94.

Milling Machines.

CINCINNATI MILLING MACHINE CO., Cincinnati.—Catalogue containing examples of rapid milling. The catalogue is well printed and illustrated. 6 by 9 in.; pp. 64.

Mining Machinery.

CHALMERS & WILLIAMS, Chicago.—Catalogue No. 1 illustrates and describes gold and silver mill machinery, together with tables giving dimensions, weights, etc.

Paints.

LOWE BROS. CO., Dayton.—Four catalogues treating of preservative and protective paints for railway, structural and manufacturing purposes.

Pattern Shop Equipment.

FOX MACHINE CO., Grand Rapids.—Catalogue No. 27 illustrating and describing complete pattern shop equipment for both wood and metal pattern work. 6 by 9 in.; pp. 64.

Pavement.

WARREN BROTHERS CO., Boston.—A number of pamphlets describing bitulithic pavement and containing many illustrations showing streets on which this pavement has been employed.

Pulverizers.

RAYMOND BROS. IMPACT PULVERIZER CO., Chicago.—Catalogue No. 8 treats of automatic pulverizers, roller mills, vacuum, air and screen separators, crushers, special exhaust fans and dust collectors. Illustrated. 7 by 10 in.; pp. 80.

Rail Joints.

ATLAS RAILWAY SUPPLY CO., Chicago.—Catalogue briefly illustrating and describing rail joints, steel joints and rail braces. 9 by 6 in.; pp. 38.

Railway Supplies.

GENERAL ELECTRIC CO., Schenectady, N. Y.—Large, well-printed catalogue, bound in cloth, illustrating and describing railway line material devices, together with tables giving prices. 8¼ by 10¾ in.; pp. 234.

Time Recorders.

CALCULAGRAPH CO., New York.—A number of pamphlets illustrating and describing the many uses to which a calculagraph may be adapted.

SYRACUSE TIME RECORDER CO., Syracuse.—Booklet illustrating and describing time recorders. Also contains illustration showing the method of keeping the time. 5 by 8 in.; pp. 16.

Time Stamps.

AUTOMATIC TIME STAMP CO., Boston.—A number of circulars illustrating and describing the various uses to which this stamp may be adapted.

Tramways.

A. LESCHEN & SONS ROPE CO., St. Louis.—Catalogue describing aerial wire rope tramways and their application to the transportation of material over great distances. 9 by 6 in.; pp. 24.

Valves.

GOLDEN-ANDERSON VALVE SPECIALTY CO., Pittsburg.—Leaflet illustrating and describing valves for railroad service, together with other railroad specialties.

Wind Mills.

FLINT & WALLING MFG. CO., Kendallville, Ind.—Catalogue No. 46 illustrative and descriptive of wind mills, towers, tanks and pumps. 5¼ by 8½; pp. 64.

Wire Rope.

JOHN A. ROEBLING'S SONS CO., Trenton.—Catalogue and price list of wire rope, iron, copper, brass and steel wire, and telegraph and telephone wire. 6 by 9 in.; pp. 164. Also a catalogue treating of cableways, tramways, suspension bridges, etc. 6 by 9 in.; pp. 116.

IMPROVED MACHINERY

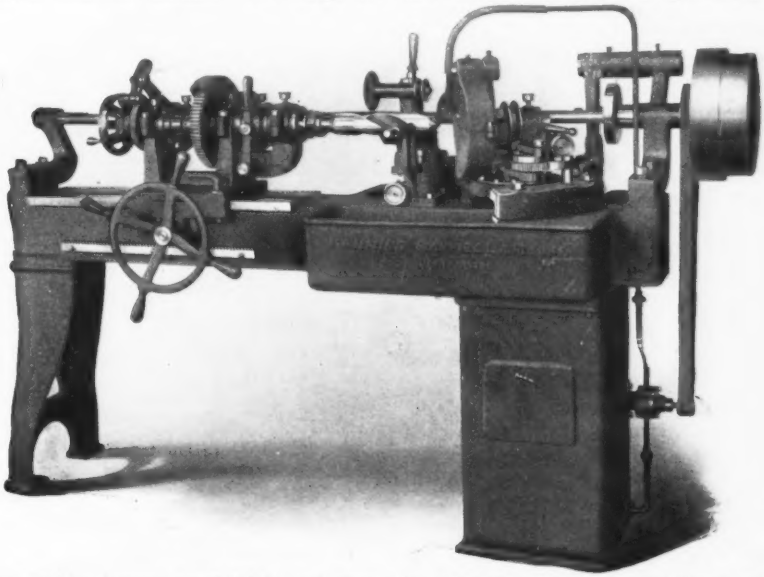
New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Dahl Automatic Drill Grinder.

THIS machine is capable of grinding drills ½ inch to 3½ inches in diameter, and is the only grinder on the market which will work entirely automatically. This enables an unskilled operator to grind a drill at a true angle without difficulty. The machine is equipped with simple and rapid adjustment for taking care of drills of different sizes. No centering of drill is required, as the grinding takes place while the drill is being revolved. Drills are pointed after grinding without being removed from the machine. The design of the machine insures equal height and even cutting on the lips of the drill. The wear on the face of the emery wheel is uniform, therefore no equalizing of wheel is required. Gauges are provided on the head of the machine for adjusting wheel for various diameters. There is also micrometer adjustment for adjusting the wheel to cover allowance for wear. The machine weighs approximately 1,900 pounds, is furnished with one large emery wheel, one small wheel for pointing, necessary rest for end of drills and bushings for the taper shanks. A wide range of automatic feed is provided. Each machine is furnished complete with countershaft, water attachment and necessary wrenches.

It is made by Manning, Maxwell & Moore, 85-87-89 Liberty Street, New York.



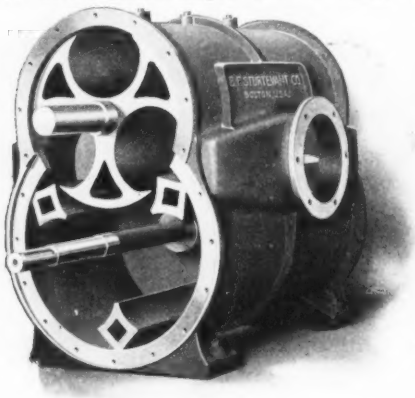
Sturtevant High Pressure Blowers.

TO complete its line of air- and gas-moving machinery the B. F. Sturtevant Co. has recently placed upon the market a high-pressure blower, of the so-called rotary or positive type, capable of furnishing air or gas for any purpose at a pressure not exceeding ten pounds per square inch. In first cost and conditions of operation, this blower stands between the centrifugal fan and the piston-type air compressor. It

is made in many sizes, having capacities ranging from 5 to 15,000 cubic feet per minute.

But few parts are required to make up this machine; two rotating members, or rotors, called the impeller and idler, and two stationary parts, the casing and a core. The rotors are mounted on two parallel shafts held in position by bearings in the end plate of the shell. The shafts are made to revolve at the same speed by spur gears which are encased to protect them from dirt and accident.

The work of compressing and moving the air or gas is done by the impeller which is mounted on the driving shaft. It consists of three diamond-shaped bars or blades



made in one piece with a central web and hub which is keyed to the steel shaft. Being a symmetrical casting it is perfectly balanced for all speeds. As it revolves in the larger part of the casing it forms three separate pockets in the annular space between the shell and the stationary cylindrical core. In these pockets the air is imprisoned and carried round to the discharge side.

The other rotor, called the idler, does no work. Revolving in the smaller portion of the casing, it provides an opportunity for the impeller blades to pass to the suction side of the blower without loss of compressed air. This is the only duty of the idler, and since it does no work and the air offers no resistance to its rotation, the only power transmitted by the gears is that necessary to overcome the slight friction of the bearings. Furthermore, the gears need not be changed for different pressures.

The casing is simply a casting of ample strength and rigidity to withstand the strains of handling and operation. The end plates are provided on the outside with chain-oiling bearings. From the inside of each end plate extends a cylindrical core.

Probably the most striking feature of this design is the great clearance between the rotating members; in fact it is at least one-eighth inch in small blowers, and from one-half to three-quarters inch in the larger sizes. The clearance between the rotors and the casing, while not as great as between the rotors themselves, is sufficient to prevent internal friction. Because of this ample clearance the journal boxes need not have elaborate adjustments which are liable to get out of order.

The foregoing brief description of the impeller gives a hint as to the principle of operation. The air or gas entering the suction side is successively imprisoned in the three annular pockets, and since the volume of these pockets is decreased by the impeller blades passing into the idler spaces, the air increases in density as it moves to the discharge side. The displacement of free air per revolution is constant, the pressure at discharge varying with the speed and the resistance encountered.

When used as a gas exhauster or for transferring air or gas at high pressure, the shafts are provided with stuffing boxes where they pass through the end plates.

Advantages of Liability Insurance.

THE need for protection on the part of employers of labor against claims or suits for damages by employees who are injured in their service is now universally recognized. There are several ways of meeting this need. It has been the custom of some employers to rely on their good treatment of the injured men to free themselves from the annoyance of claims and suits. They pay the wages, hospital and doctors' bills during disability, and then hope that the men will feel well treated and will return to work without giving trouble.

From a humanitarian viewpoint, this should be true, but two most important elements nullify it. One is the almost universal activity of the shyster lawyer, and the other, the widespread and growing hostility toward the capitalistic or employing class displayed by working men. These two elements, one re-inforcing and stimulating the other, will in nearly every case more than offset any efforts at conciliation made by the employer. Another means used by some employers is that of setting aside, each year, a sum of money toward a reserve fund upon which they draw as needed for the settlement of claims. This is, with them, a fixed expense. They count on it each year as one of their liabilities. It should be noted, however, that any such reserve fund, to be at all adequate, must be sufficiently large to provide for the payment of an occasional judgment for $5,000 or more in a case resulting in death or serious permanent injuries. The objection to this course is that it requires a considerable amount of money to be held in idleness, thus tying up capital which should be, and most likely ought to be, used in extending and developing the business, purchasing new and more up-to-date equipment, etc. Another method of dealing with such matters is through employers' liability insurance.

The employer who has one of these policies, provided the company issuing it is sound and the policy liberal, is at the end of his troubles. The only expense is the premium rate, which is necessarily very much lower than his so-called reserve fund would have to be, as it is based on what is known in insurance circles as the law of average—*i. e.*, the record of those plants having no losses helps to reduce the net cost to each policyholder. The protection secured is absolute; the possibility of a large loss, which might impair his credit and even seriously cripple his resources, is averted, and he knows that his case will be taken care of by men who are specialists in that work, and who know best how to settle just claims and fight unjust ones. He is thus left to devote his entire time to the study of his business.

The Maryland Casualty Company of Baltimore has just issued a new form of policy, a distinct departure from the standard form as sold by other companies, which frequently caused serious embarrassment to employers by reason of the vexatious conditions it contained. This new policy is called the "Perfect Form," and is notable for the absence of technicalities; in fact, it is a conditionless policy—something that has long been needed.

The Grant Governor.

AN ingenious steam-engine governor, in which the effects of inertia and centrifugal force are combined for controlling the cut-off, has been devised by Mr. Charles Grant. Its characteristic features are an inertia ring and a pair of centrifugal fly-balls, with their details.

The complete governor, as shown in Fig. 1, consists of a rigidly driven ring, an inertia ring of the same diameter resting on balls located in races cut in the facing edges of the two rings, two fly-balls pivoted to the knuckles of two pairs of toggle links which connect the two rings, and a cam and lever mechanism for transmitting to the governor spindle any relative motion between the two rings. The

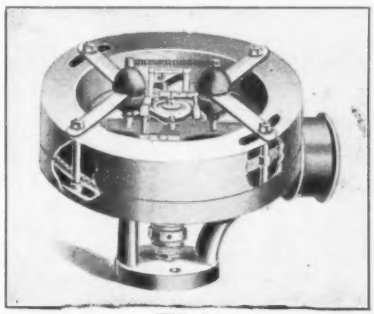


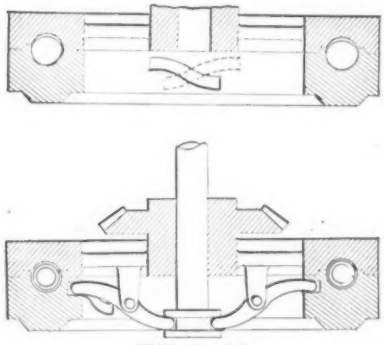
FIG. 1.

upper ring of the two is the inertia ring; one link of each pair of toggle links is pivotally attached to this ring, and the other link of each pair is pivoted to a stud which is screwed into the lower ring and projects through a slot in the upper ring.

The toggle links connecting the two rings are so arranged that if the driving ring accelerates, leaving the inertia ring momentarily behind, the knuckles on which the balls are mounted will be drawn outwardly, and through the connecting mechanism will actuate the governor spindle and so alter the cut-off.

The web of the lower ring carries two posts in which are pivoted levers, as shown in Fig. 2. One end of each lever extends into a curved cam slot in the inner circumference of the inertia ring, and the other engages with the collar on the governor spindle. The cam slot is shown in Fig. 3, which is a cross-section of the rings taken 90 degrees from the cross-section in Fig. 2. It is obvious that if the upper (inertia) ring moves relatively to the lower ring, the levers will be raised or lowered, according to the direction of relative motion.

The shape of the cam slots is a hyperbolic curve, which constitutes one of the special features of the Grant governor, and is laid out so that the governor spindle will be moved practically the same distance by the same degree of speed



FIGS. 2 and 3.

change at all points within the range of the governor. This could not be accomplished with straight diagonal slots.

The inertia ring and the balls thus cooperate in moving the governor spindle. The action of centrifugal force on the balls is opposed by a spring from ball to ball. Only a light spring is required, however, and the balls are much smaller than would be necessary in the pendulous forms of fly-ball governor.

In practice it is found that the engine cannot be started at full speed, the governor acting so sensitively as to partially close the valve when the engine is at something like half speed, after which it opens the valve gradually to admit the amount of steam required to maintain the given speed. In reboring an unevenly worn cylinder on a Prince Line steamer a one-inch governor used on a 10-horse-power engine operated so as to open and close the full throw of the valve without any detectable change of speed.

Further details of this interesting governor can be obtained from the inventor, Charles Grant, 224 Tompkins Avenue, Brooklyn, N. Y.

Tests of Woods for Paving Purposes.

PRACTICALLY all of the wood pavements which have been laid of recent years in the United States have been of long leaf pine blocks. The increase in the price of this wood is beginning to limit its use for this purpose and investigations are under way by city authorities, by the Department of Agriculture and by wood paving contractors to determine what other woods can be used for pavements.

In a paper read by Mr. F. A. Kummer, before the American Society of Municipal Improvements, he says:

"In any determination as to the value of a wood for paving purposes, if we start with the assumption that by filling the pores of the wood throughout the block completely with a good quality of creosote oil, decay can be prevented, there remains only one other question to be decided, and that is whether the wood is sufficiently dense, tough and hard to successfully resist heavy travel. Such a determination is not a very difficult matter. In fact, it is almost self-evident that using Georgia pine as a standard, any block which is as hard or harder than this wood should give equally as good or better results, while those blocks which are not so hard—such, for instance, as short leaf, loblolly and Norway pine should give less satisfactory results. The writer believes that all these woods can be used for paving purposes if properly treated, but should be used with discrimination. A street laid with loblolly pine under moderate travel might readily give a serviceable life of twenty years or more, while a similar pavement under the excessively heavy travel found on such streets as exist in the lower part of New York City, would probably be destroyed very quickly. The length of life of a wood block pavement is not directly proportional to the travel. Take, for instance, two streets laid with the same wood in the same manner. If the traffic on one street approaches but does not reach

the limit of durability of the wood, the pavement will last almost indefinitely, because the character of the traffic is not sufficiently heavy to destroy it; but if the traffic in its character as well as amount passes the limit of durability of the wood employed, the pavement will be destroyed in a comparatively short time. It would seem that for each class of timber there is a condition of traffic beyond which it should not be subjected, but no determination of these limits could correctly be made except from a great number of actual service tests. In a general way, however, satisfactory results may be obtained by dividing the streets into three classes: heavy, medium and light travel. On the third class of streets practically any wood which would not decay would give an indefinite life. On the second class discrimination should be used, although woods as soft as Norway pine have given excellent results under these conditions. On the first class of streets it would probably be dangerous to lay any wood less durable and resisting than the best quality of long leaf pine. So far the writer does not know of any available wood other than the Black Gum before mentioned which could be safely included with long leaf pine in this category. By this, of course, is meant woods which can be obtained in large quantities commercially, and which possess the element of toughness rather than that of extreme hardness.

The writer has found from long experience that streets laid with blocks, some of which are hard and some soft, will wear very badly, while the same street laid with all soft blocks would wear very well. This is due to the well-known way in which one soft block will affect its neighbors, the wear extending from the one spot like a disease. The most perfect example of this that the writer has seen was in Havana this summer. The United States Wood Preserving Company, some five or six years ago, furnished to the Highway Department of the city of Havana several hundred yards of yellow pine block for a test on one of the heaviest traveled streets in that city. These blocks were of the old size, 4 inches by 4 inches by 4 inches by 8 inches, and in laying them, careless workmen sometimes put them down with the grain horizontal instead of vertical. The street in question has a very heavy travel of two-wheeled carts carrying heavy loads. Six blocks were laid in this street the wrong way. At the end of some five years there are six shallow depressions in this street some 24 inches in diameter and perhaps 2½ to 3 inches deep, perfectly regular and having at the bottom of each, in the exact center, a block laid the wrong way. With the exception of these six holes the street is in perfect condition. This shows clearly the way in which a soft block or a block wearing more rapidly than the surrounding blocks will infect, as one might say, its neighbors."

Mr. Kummer's conclusions are that the requirements of wood paving are met in a commercially practicable way by black gum, Oregon pine and Norway pine, as well as, of course, long leaf yellow pine, which is now in successful use. Future experiments may discover other woods suitable for the purpose.

The Anderson Float Valves.

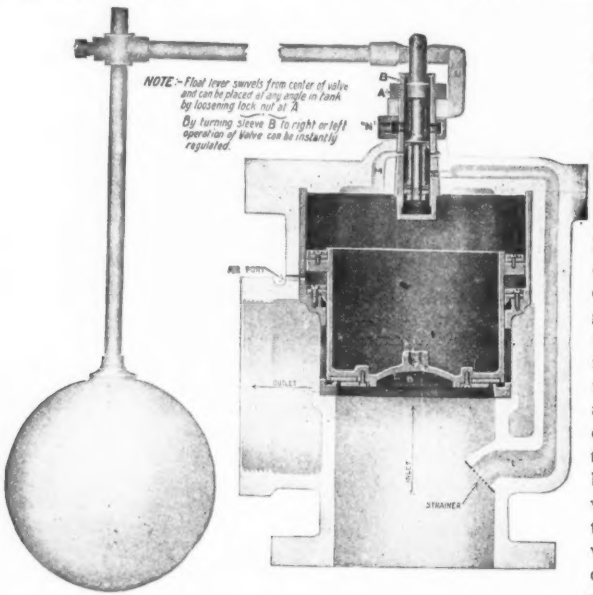
THE Anderson Automatic Angle and Straightway Float Valves are of a heavy pattern, first-class material and workmanship, and owing to their correct mechanical construction will operate under all the varying pressures up to and including 175 pounds. They are absolutely the most satisfactory float valves known.

Referring to the sectional cut, attention is called to the upper portion of the body being lined with bronze, the piston or valve being solid bronze fitted with rubber cups and seat, preventing any wear of the liner or valve, which makes the valve indestructible, due to the easy operation, which is as follows: The water coming under the piston or valve B also enters through port L and M on top of the valve. Owing to the greater area above the valve, it is held closed. When the lever is operated by the float, the auxiliary valve closes port L and opens port through auxiliary valves for exhaust at N. Owing to the pressure on top of the valve being removed, the pressure under the valve forces it open. The water above the valve acts as a cushion in opening, and as the valve travels upward, it draws in air through ports in the sides

of the body to cushion the valve when closing.

The valve being in a vertical position with the pressure acting directly under or on top of the valve when operated, practically eliminates friction and stamps it as the most positive and economical valve known. Attention is also called to the regulating auxiliary valve which is all bronze and so constructed that by loosening the lock nut A and turning the sleeve B to the right or left, the operation of the valve can be instantly regulated to operate quickly or slowly as desired.

Made by the Golden-Anderson Valve Specialty, Pittsburg, Pa.


NOTE:- Float lever swivels from center of valve and can be placed at any angle in tank by loosening lock nut at A
By turning sleeve B to right or left operation of valve can be instantly regulated.
B
A
AIR PORT
OUTLET
STRAINER

Three-Machine Motor Generator Sets.

ALLIS-CHALMERS Company has recently been awarded a contract for three motor-generator sets to be used in an extension of the works of the Niagara Electro-Chemical Company at Niagara Falls, N. Y. The sets are of the synchronous type operating at 500 revolutions per minute, 25-cycles 2200 volts. Each set consists of three machines, the synchronous motor being coupled to a direct current generator at each end by means of flange couplings. Each direct current machine generates current at a maximum pressure of 105 volts and has an output of 200 k. w., the voltage being capable of variation through a considerable range. The sets have four bearings and the design is such that either direct current machine can be disconnected, in case repairs are necessary, without interfering with the operation of the remaining machine.

The service which these sets have to perform is exceptionally severe, as the load is continuous day and night for several weeks at a time, without opportunity for a shut-down of any kind. The current is used for the electrolytic reduction of metallic sodium from sodium hydroxide, and the process is an uninterrupted one. Each direct current generator furnishes current to a series of pots in which the electrolytic reduction is carried on, and by using three-machine sets the voltage on the series of pots supplied by any machine can be varied independently, thus giving a decided advantage over a single direct current machine of twice the output.

Each set will be provided with a three panel switchboard; one alternate current motor panel and two direct current generator panels. The sets will be arranged for starting from the direct current end and the synchronous motors will be excited from the direct current machines. Power for operating will be supplied from the large plant of the Niagara Falls Power Company.

NEWS SUPPLEMENT

The Engineering Magazine—January, 1907

Personal.

—M. B. Porter has been appointed sales manager of the Pittsburgh Gage & Supply Co., Pittsburgh.

—G. K. Hooper, 11 Broadway, New York, has been elected vice-president of the Weir Frog Co., Cincinnati, and a director of the American Tracing Cloth Co.

—H. Van Atta, formerly superintendent of The J. L. Mott Iron Works, has joined the organization of G. K. Hooper, consulting engineer, New York.

—Horatio A. Foster announces his association with L. B. Stillwell, consulting electrical engineer, and his removal to Baltimore as resident engineer in charge of Mr. Stillwell's Baltimore office at 1314 Continental Bldg.

—Robert McF. Doble, Colorado Springs, formerly of San Francisco, has been retained as consulting and supervising engineer by Curtis & Hine, general managers of the recently organized Central Colorado Power Co., in the development of their large hydro-electric power projects on the Grand River, Colo.

Industrial Notes.

—Massachusetts Fan Co., Waltham, Mass., announce that they have moved into their new plant.

—Keystone Driller Co. has opened an eastern sales and export office at 170 Broadway, New York.

—The Link-Belt Co. has recently opened an office at 913 Missouri Trust Bldg., St. Louis. E. C. Berghoeffer is in charge.

—George N. Pierce Co., announce that the factory offices have been removed from 18 Hanover Street to their new works, 1695 Elmwood Ave., Buffalo.

—Allis-Chalmers Co., Milwaukee, have recently installed two Allis-Chalmers engines, 38" x 80" x 60" in the 40th Street power station of the South Side Elevated Railway, Chicago.

—The Carnegie Steel Co., have placed an order with the Buffalo Forge Co., Buffalo, for ten gas cleansing fans. These fans are each to handle 15,000 cubic feet of gas per minute.

—Forge shop equipments are being installed by the B. F. Sturtevant Co., Boston, for the National Rolling Mills, McKeesport, Pa., and the Knickerbocker Ice Co., Chicago.

—Two induced draft fans are being built for the power station of the East St. Louis & Suburban Railway Co., by the Green Fuel Economizer Co., Matteawan, N. Y.

—Chicago Pneumatic Tool Co., Chicago, are now adding another 150 feet to their machine shop which will increase their present capacity from 55 to 70 compressors per month.

—The mechanical division of the Department of Water Supply, Gas and Electricity would be pleased to receive at Room 932, No. 13 Park Row, New York, catalogues of pumps, boiler-room fittings and supplies.

—Buffalo Forge Co., Buffalo, have closed a contract with Illinois Steel Co., to furnish two centrifugal water spray gas cleansing fans. These will be used in their plant at Bay View, Wis.

—The Curtin-Ruggles Co., 39 Cortlandt Street, New York, have acquired the eastern agency for the Youngstown Iron & Steel Roofing Co., Youngstown, manufacturers of Youngstown expanded metal, expanded metal lath, and patent studding and furring strips.

—Recent orders taken by the B. F. Sturtevant Co., Boston, for high pressure blowers of the rotary type include Berry Engineering Co., Chester, Pa.; Crane Co., Chicago; Kansas City Portland Cement Co., Kansas City; and Heany Fire Proof Wire Co., York.

—The Central Electric Co., Chicago, has contracted with the Allis-Chalmers Co., Milwaukee, for furnishing a 16" x 36" Allis-Chalmers "Reliance" Corliss engine, direct coupled to a 250 K. W. Allis-Chalmers alternator, with exciter, for the Pullman Company, Pullman, Ill. The alternator is a 2300 volt, 60 cycle, 3 phase machine.

—The B. F. Sturtevant Co., Boston, is installing complete equipments of the blower system of heating and ventilation in the following: 18 stall round-house of the Canadian Pacific Railway Co., Broadview, Saskatchewan, P. Q.; and car repair shops of the Somerset Railway Co., Oakland, Me.

—The Peerless Woolen Mills, Rossville, Ga., will install an extensive new engine-generator and induction motor equipment recently purchased from the Allis-Chalmers Co., Milwaukee. The prime mover is a 20" x 36" Allis-Chalmers "Reliance" Corliss engine, bolted to a 250 K. W. Allis-Chalmers alternator.

—The equipment for the New Gansevoort and Oliver Street Stations of the Borough of Manhattan, comprising ten Allis-Chalmers multistage, centrifugal pumps each with a capacity of 3000 gallons per minute, will be driven by ten Allis-Chalmers induction motors of 800 H. P. each, which are being supplied in accordance with the specifications of the Department of Water Supply, Gas and Electricity.

—Sturtevant economizers are being installed by the Burgess Mills, Pawtucket; The Champion Fibre Co., Canton, N. C.; and J. B. King Co., Staten Island, N. Y. In connection with the former the B. F. Sturtevant Co., Boston, Mass., is furnishing a dual system of mechanical draft consisting of a fan for forcing air beneath the grate and another for exhausting gases from the furnace.

—Large installations are being made by the B. F. Sturtevant Co., Boston, for heating the following plants by the blower system: National Cash Register Co., Dayton; St. Joseph Lead Co., Bonne Terre, Mo.; Manufacturers Furniture Exchange, Chicago; Jefferson Glass Co., Follanebee, W. Va.; Canada Paint Co., Ltd., Montreal; and American Vulcanized Fibre Co., Newark Center, Del.

—Robb-Mumford Boiler Co., So. Framingham, Mass., have been awarded the contract for furnishing twenty-four 84" x 19'-6" horizontal return tubular boilers to be installed at Culebra, Isthmus of Panama. They have also secured the following contracts: Three 200 H. P. boilers for the Orleans Ice Mfg. Co., New Orleans; six new locomotive boilers for the Boston & Albany R. R.; a 150 H. P. boiler for the Ames Shovel & Tool Co., No. Easton, Mass.; and a 125 H. P. boiler for the Camden Wool Co., Camden, Me.

—Pittsburgh Gage & Supply Co., Pittsburgh, announce that they are installing White Star continuous oiling systems for the following companies: Brier Hill Iron & Coal Co., Youngstown; Embree Iron Co., Embreeville, Tenn.; Bullock Electric Mfg. Co., East Norwood, O.; Sargent & Co., New Haven; National Car Wheel Co., West Homestead, Pa.; Copper Queen Construction Mfg. Co., Douglas, Ariz.; Brush Electric Light & Power Co., Galveston; Illinois Steel Co., Joliet; and Consolidated Gas, Electric Light and Power Co., Baltimore.

—The following sales of enclosed forced lubrication engines are reported by the B. F. Sturtevant Co., Boston: C. H. Mears & Co., Chicago; Old Dominion S. S. Co., Norfolk; Swedish Hospital and Nurses Institute, Minneapolis; Belmar Mfg. Co., Canton, Pa.; Phoenix Woolen Co., Stafford, Conn.; Hoopes & Townsend Co., Hoopeston, Pa.; Manufacturers Furniture Exchange, Chicago; Silver Bros. Iron Works Co., Salt Lake City; Burgess Mills, Pawtucket; Narragansett Mills, Fall River; U. S. Navy Yard, Washington, D. C.; Henry Steers, Inc., New York; and G. H. Breymann & Bros., Boston.

—Mechanical Draft Apparatus has been recently sold to the following by the Buffalo Forge Co., Buffalo: Geophysical Laboratory—Carnegie Institution of Washington. 50" steel plate fan for forced draft with shaft arranged for sprocket and chain drive; Merchants Electric Light, Heat and Power Co., York, Pa. 90" steel plate steam fan for induced draft driven by a 6 x 6 single vertical double acting engine; Orange Brewery, Orange. 100" steel plate pulley fan for induced draft direct connected to 6 x 6 engine; and Iroquois Iron Works, Buffalo. 90" pulley fan.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

INGERSOLL-RAND Co., New York.—Catalogue X 36, illustrating and describing type 10 air compressors, steam and power driven, together with tables containing much valuable data. 6 by 9 in.; pp. 40.

Boilers.

EDGE MOOR IRON Co., Wilmington.—Cloth bound catalogue, illustrates and describes water tube boilers. Also contains views of plants in which their boilers have been installed, together with a partial list of users. 6 by 9 in.; pp. 94.

Cement.

WM. G. HARTRANFT CEMENT Co., Philadelphia. —Catalogue entitled "The Diversified Uses of Portland Cement," containing many illustrations showing buildings on which this cement has been employed. 6 by 9 in.; pp. 84.

VULCANITE PORTLAND CEMENT Co., Philadelphia.—Well printed book treating of portland cement, together with a list of users, testimonial letters and views showing buildings on which this cement has been employed. 7¼ by 9¼ in.

Coal Handling Machinery.

WELLMAN-SEAVER-MORGAN Co., Cleveland.—Fine large catalogue, printed in two colors and bound in cloth, illustrating and describing ore and coal handling machinery, together with many views showing recent installations. 9 by 12 in.; pp. 112.

Concrete Block Machines.

THE PETTYJOHN Co., Terre Haute, Ind.—Catalogue illustrating and describing hollow concrete building block machines. 6 by 9 in.; pp. 32.

Concrete Mixer.

MUNICIPAL ENGINEERING & CONTRACTING Co., Chicago.—Well-printed catalogue, illustrating and describing cube concrete mixers. 10 by 7 in.; pp. 20. Also a pamphlet devoted to an illustrated description of sewer excavators. 10 by 7 in.; pp. 10.

Concrete Piling.

SIMPLEX CONCRETE PILING Co., Philadelphia. —Pamphlet describing concrete piling for use in foundation work. Contains many views of buildings resting on concrete pile foundations. 4¾ by 9¾ in.; pp. 36.

Crushing Rolls.

STURTEVANT MILL Co., Boston.—Pamphlet treating of crushing rolls. Illustrated. 7 by 11 in.; pp. 8.

Gages.

CROSBY STEAM GAGE & VALVE Co., Boston.—Catalogue, bound in cloth, illustrating and describing pressure and vacuum gages, recorders, thermometers, valves, pump valves, etc., together with prices. 6 by 9 in.; pp. 220.

Gold Dredging Machinery.

URIE-SNYDER DREDGE Co., Kansas City.—Catalogue F, devoted to an illustrated description of gold dredging machinery. 11 by 8 in.; pp. 28.

Hoisting Engines.

CRAWFORD & MCCRIMMON Co., Brazil, Ind.—Catalogue containing an illustrated description of hoisting and hauling engines. Ventilating fans and acid proof pumps are also treated. 5 by 8 in.; pp. 44.

Locomotives.

AMERICAN LOCOMOTIVE Co., New York.—Catalogue illustrating and describing consolidation type freight locomotives weighing more than 175,000 pounds. 9 by 6 in.; pp. 68.

Logging Cars.

RUSSELL WHEEL & FOUNDRY Co., Detroit.—Catalogue illustrating and describing logging cars, together with dimensions, capacities, etc. 9 by 6 in.; pp. 56. Also a pamphlet showing some buildings recently constructed by their engineering department. 6 by 9 in.

Lubrication.

JOSEPH DIXON CRUCIBLE Co., Jersey City.—"Air Compressor Lubrication" is the title of a booklet containing extracts from articles that have appeared in engineering periodicals treating on this subject. 6 by 9 in.; pp. 24.

Machine Shop Equipment.

NILES-BEMENT-POND Co., New York.—No. 14 of the "Progress Reporter" is devoted to an illustrated description of the machine shop equipment of the Midvale Steel Co.'s plant. 9 by 12 in.; pp. 48.

Magnetic Separators.

DINGS ELECTRO-MAGNETIC SEPARATOR Co., Milwaukee.—Bulletin No. 18 describes the merits of type M M magnetic separators for use in concentrating and separating ores and mineral products. Illustrated. 4 by 9 in.; pp. 16.

Metal Cabinets.

ART METAL CONSTRUCTION Co., Jamestown, N. Y.—Well-printed catalogue illustrating and describing metal cabinets for the filing of plans, specifications and other valuable documents. 9 by 6 in.; pp. 72.

Mixing Machinery.

DRAKE STANDARD MACHINE WORKS, Chicago.

—Catalogue C containing an illustrated description of continuous and batch mixing machinery for concrete, asphalt and mortar. 6 by 9 in.; pp. 136.

Motors.

GUARANTEE ELECTRIC CO., Chicago.— Catalogue and price list illustrating and describing variable speed motors, for alternating and direct current.

Pumps.

SANDUSKY FOUNDRY & MACHINE CO., Sandusky, O.—Catalogue A devoted to an illustrated description of pumping machinery for all services, together with tables giving capacities. 5¼ by 8 in.; pp. 24.

Recording Gauges.

THE BRISTOL CO., Waterbury.—Catalogue No. 44 illustrating and describing recording pressure gauges. Also contains many tables giving much valuable data. 8 by 11 in.; pp. 28.

Regulators.

RICHARD THOMPSON & CO., New York.—Catalogue describing damper and pressure regulator for regulating and controlling high and low pressure steam boilers, etc. Illustrated. 6 by 9 in.; pp. 20.

Reinforced Concrete.

INTERNATIONAL FENCE & FIREPROOFING CO., Columbus, O.—Catalogue illustrating and describing the International system of reinforced concrete, together with views showing buildings erected under this system. 10½ by 8½ in.; pp. 16. Also two pamphlets treating. concrete mixers and fences and gates.

Rheostats.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO., Pittsburg.—Circular No. 1139 is devoted to an illustrated description of starting and field rheostats. 6 by 9 in.; pp. 20.

Rock Drills.

STANDARD DIAMOND DRILL CO., Chicago.—Catalogue illustrating and describing diamond rock drills, together with price lists. 6 by 9 in.; pp. 94.

GARDNER ELECTRIC DRILL AND MACHINERY CO., Cleveland.—A number of bulletins illustrating and describing rock drills. Also contains a statement of comparative cost of compressed air, steam and electric rock drills, including installations and operating expenses. 8 by 11 in.

Roofing.

LINCOLN WATERPROOF CLOTH CO., Bound Brook, N. J.—Booklet illustrating and describing roofing. 6 by 9 in.; pp. 32.

Roofing Tin.

N. & G. TAYLOR CO., Philadelphia.—A number of pamphlets describing the advantages of tin roofing.

Signaling Devices.

GENERAL RAILWAY SIGNAL CO., Buffalo.—Two cloth-bound catalogues, section No. 1 treating of electric interlocking and section No. 2 of mechanical interlocking and signaling devices. 6 by 9 in.

Skylights.

THOS. W. IRWIN MFG. CO., Allegheny.—Catalogue illustrating and describing skylights, together with views showing some buildings on which they are used. 9 by 6 in.; pp. 24.

Smelting Furnaces.

ALLIS-CHALMERS CO., Milwaukee.—Bulletin No. 1417 treating of smelting furnaces and accessory equipment. 8 by 10½ in.; pp. 48.

Steam Engines.

WISCONSIN ENGINE CO., Corliss, Wis.—Catalogue E-3 containing numerous illustrations of the many types of engines manufactured by them. The captions contain the descriptions. 10 by 7 in.; pp. 58.

Steam Shovels.

THEW AUTOMATIC SHOVEL CO., Lorain, Ohio. —Catalogue No. 5 contains an illustrated description of steam shovels, excavators and dredges for all purposes. 9 by 6 in.; pp. 36.

Telephones.

COUCH & SEELEY CO., Boston.—Catalogue No. 8 illustrating and describing intercommunicating and interior telephones, together with prices. 6 by 9 in.; pp. 32.

Valves.

COFFIN VALVE CO., Boston.—Loose leaf catalogue illustrating and describing sluice and gate valves. 9 by 12 in.

ASHTON VALVE CO., Boston.— Catalogue No. 12 treats of pop safety and relief valves and pressure and vacuum gages. Also contains tables giving prices and sizes. Illustrated. 6 by 9 in.; pp. 120.

Wind Mills.

U. S. WIND ENGINE & PUMP CO., Batavia, Ill.—General catalogue No. 15 treating of wind mills, steel towers, wood and steel tanks, pumps, etc. Illustrated. 5 by 8 in.; pp. 268.

Wire Cloth.

LUDLOW-SAYLOR WIRE CO., St. Louis.—Catalogue No. 31 containing price list and standard gauges of double crimped wire cloth. 6 by 9 in.; pp. 68.

Wood Pipe.

NATIONAL WOOD PIPE CO., San Francisco.—Two catalogues illustrating and describing wood stave pipe for city water works, mining, electric power developments, etc.

Wood-Working Machinery.

S. A. WOODS MACHINE CO., Boston.—Catalogue containing a treatise on special wood-working machinery. The catalogue is well printed and handsomely illustrated. 6 by 9 in.; pp. 196.

IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

A Novel Frequency Changer Set.

PROBABLY the first vertical shaft frequency changer set ever built, has recently been completed at the Schenectady Works of the General Electric Company. The advantages of applying vertical turbo-generator principles to frequency changer sets have been found to have great weight in the larger capacities. Whereas in large size horizontal shaft frequency changer sets it has followed that the electrical design suffered because of the mechanical difficulties involved, in the vertical sets the machines can be properly proportioned to obtain low iron and copper losses without sacrifice to either.

From the facts, that the friction losses are small and the proportion between iron and copper losses so low and well balanced, the combined efficiencies of motor and generator in the vertical sets are very high. Tests have shown that the generator is good for a continuous output of 2,667 kw at 75 per cent. power factor without any part heating more than 40 degrees above the surrounding air. At full load output of 2,000 kw with unity power factor, the efficiency of the set is 91 per cent. while at half-load the efficiency is 85 per cent. The high efficiency of the vertical set at full load, and remarkably high efficiency at half load are due in good measure to the very low friction losses. The rise in potential of the generator when the load is thrown off, with unity power factor, is a trifle less than 6 per cent.

Aside from the higher efficiency thus obtainable, the vertical frequency changer set in the larger sizes is more compact, simpler in operation, cheaper to build, more accessible, and more adaptable to given conditions than the horizontal type heretofore built. These various advantages will be made clear by a detailed description of the new vertical sets.

Each of the new machines consists of a ten-pole, revolving field synchronous motor, operating at 9,000 volts, 25 cycles mounted on the same vertical shaft with a 24-pole revolving field generator delivering current at 4,150 volts, 60 cycles. The speed is 300 rpm and the entire weight of the revolving parts floats on the oil-film of a step-bearing, in a manner similar to that in the Curtis steam turbo-generator.

In appearance, the new set is most pleasing, the height without the direct connected exciter at the top, being almost exactly the same as the diameter. The shallow circular base supports the stationary armature of the motor, above which is placed the generator armature, of the same diameter. The generator armature in turn supports the bracket holding the upper guide bearing, and above this sets the magnet yoke of the exciter. The whole forms a perfect cylinder capped by the direct connected exciter, the monotonous appearance of the casing being broken by the vertical ribs of the "skeleton" type of armature frames, exposing to view the sectionalized, laminated armature cores.

The vertical design simplifies the construction wonderfully. The rotating element comprises a single vertical shaft supporting two distinct spiders for the motor field and generator field windings, respectively. The weight of the revolving parts is carried on a cast iron disc at the lower end of the shaft, the whole floating on an oil-film. The revolving fields are of the usual General Electric construction, having steel centers dovetailed to the poles, and coils of copper strip wound on edge. An amortisseur winding of low resistance is provided on the fields of the motor.

It might be assumed that the horizontal shaft set would be more accessible than the vertical type of frequency changer. Actually, however, the opposite is the case. as either rotors or stationary armatures may be removed by a crane without disturbing the remaining parts. By arranging a sling, the revolving field poles can be removed from the rotor spiders. Large

openings are also arranged in the frame so that any part of the machine can be reached for cleaning.

One of the most interesting ways to bring out the advantages of this latest product of electrical engineering design is to compare a 2,000 kilowatt vertical frequency changer set, with a 1,500 kilowatt set running at the same speed, but having a horizontal shaft.

Comparison vertical ferquency changer set (nominal rating 2,000 kw) with horizontal set (rating 1,500 kw).

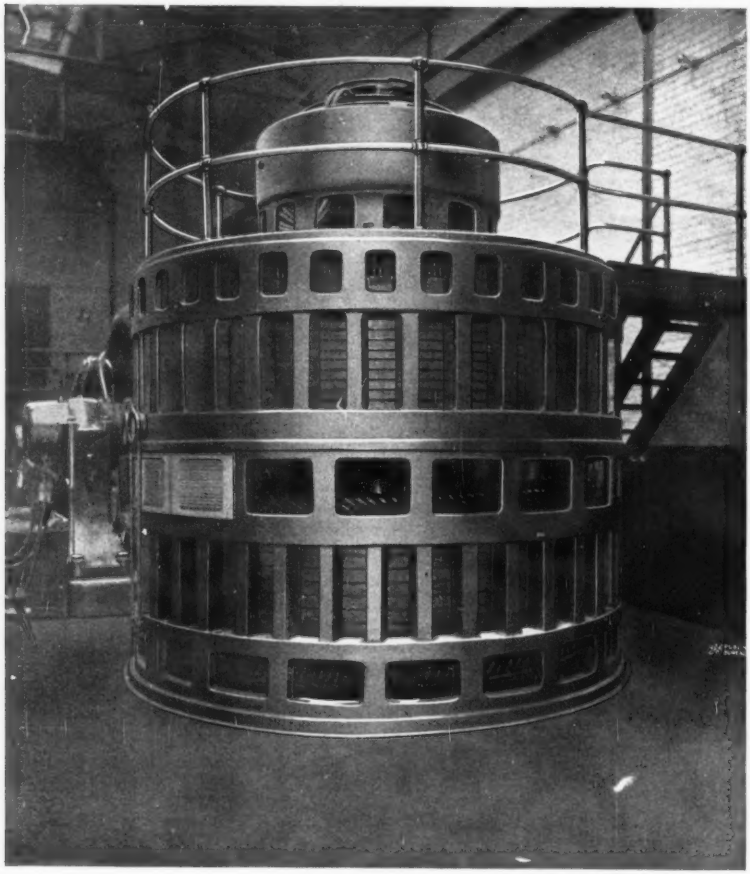
Floor space (vertical), 11 ft. 5 in. circle or 101 sq. ft. Horizontal), 17 ft. x 11 ft. 1 inch or 188 sq. ft.

Height (vertical), 11 ft. 6 in. without exciter; 14 ft., 60 in. with exciter. Horizontal), 11 ft. 6 in.

Weight (vertical), 165,000 lbs. (without exciter). (Horizontal), 160,500 lbs. (total).

Weight shaft (vertical), 5,900 lbs. (Horizontal), 9,100 lbs.

Weight mechanical parts (vertical), 29,000 lbs. (Horizontal), 49,000 lbs.



From the above comparison it will be seen that the vertical set is the better proportioned of the two and that the electrical output per pound is much greater for the vertical than for the horizontal set. When it is considered that the rating of the vertical set is virtually 2, 500 kw

rather than 2,000 kw the proportion in its favor is still more marked.

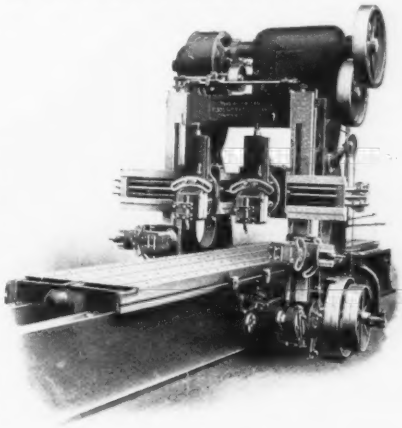
In operation, too, the new type of frequency changer has several advantages. Considerable energy is required to start a large two-bearing horizontal set, while with the vertical type, the rotor can be turned by hand as soon as it is floated on its step bearing. In practice, the exciter is used to bring the machine up to synchronous speed. Another point in favor of the vertical set in commercial operation is the fact that there is no danger of the bearings wearing sufficiently to allow the fields to hit, as there would be in a horizontal machine. Moreover, the relative positions of the armatures of the motor and generator can be changed much more readily in a vertical set than in a horizontal unit, and this renders it much simpler to make each set take its proper share of the load.

"American" Variable Speed Planers.

THE necessity for "reduction in shop cost" having advanced to such a degree of late and the requirements of machine tools to meet these conditions, has led The American Tool Works Co., Cincinnati, Ohio, U. S. A., to develop a line of variable speed planers. In reducing planing costs to a minimum, the up-to-date works manager often requires variable cutting speeds to cover different classes of work in hand. The "American" variable speed planers are built to suit these requirements and the manufacturers request that customers inform them correctly as to the nature of their work in order that they may recommend and bid on the most suitable machine for them. They build two types of variable speed planers; one with four cutting speeds and the other with two cutting speeds each type having a constant speed return of the platen which is greatly in excess of its respective highest cutting speed. A description of these two types is given below.

In the four-speed planer the charges are obtained through a speed box. The four speeds are taken from a carefully chosen range, calculated to cover all requirements of modern planer work. These, with the constant high speed return of the platen, insure the greatest working economy.

The speed box is securely bolted to the top of housings, these being of special design and very substantial. It is symmetrical in appearance and being completely closed insures the greatest economy of oil consumption and absolute freedom from flying oil. All shafts in the speed box run in long bronze bushed bearings perfectly lubricated by the "ring" or "dynamo" system of oiling. The gears run in oil, thus giving the longest life and least noise to these parts. They are of ample proportions, wide face and course pitch. The pinions are all steel and cut integral with their shafts. Gears and pinions are cut with special cutters insuring the greatest accuracy, longest life and minimum noise. Any of the four speeds may be obtained by the simple manipulation of two con-



venient levers. A safety locking device prevents the engaging of two conflicting speeds at the same time, and an index plate shows clearly how to obtain the desired speed.

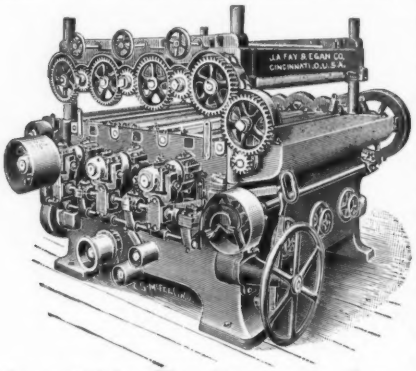
The driving pulleys have fly wheel rims, the momentum of which reduces to a minimum all shocks to the driving mechanism due to intermittent cutting and insuring at reversing a steady, even pull at the cutting tool. They are perfectly balanced, running without vibration even on the highest speeds. This, coupled with a scientifically designed and accurately built planer in all its details, results in a finished job of planing so smooth and perfect that it requires the least, if any, attention from the vise hand in fitting.

Belt or electric motor drive may be furnished. When motor driven, should the motor become disabled, the driving pinion on outside of speed box may be replaced by a pulley and the planer driven by belt from a countershaft, or another motor conveniently placed. The flexibility of this construction insures the constant use of the machine at all times. When belt driven, the planer may be readily converted into motor driven at any time after installation.

In the two-speed type the speeds are obtained through a simple and efficient two-speed countershaft, which is attached to the ceiling in the usual manner. The self-oiling feature of this countershaft minimizes attention to it and insures the longest life.

Triple Drum Sander.

THE accompanying cut represents the Fay & Egan Co.'s No. 4 improved triple drum sander. It is designed with a view to overcoming all those undersirable features associated with machine sanded work, such as snake lines, furrows and waves, faulty feed frequently causing veneered work to be sanded through, concaved or dubbed cornered. The success of this aim is secured by the oscillating movement of its three drums laterally across



the material. The drums carry three grades of sandpaper, the third or last being the finest, after which the work is dusted thoroughly by a rapidly revolving brush. When the sandpaper is worn out the drums can be easily recovered by any practical workman, a point of advantage not found on any other sander of this class.

The feeding mechanism consists of eight powerful rolls, four above and four below the platen. The frame carrying the upper feed rolls can be elevated automatically or by hand wheel to receive material up to 8 inches in thickness. The rolls are driven by a train of heavy expansion gearing, insuring a perfect steady feed. All levers and hand-wheels are convenient to the operator. The machine practically finishes the work ready for the filling room or for varnishing. Further detailed particulars concerning the same may be obtained by addressing the J. A. Fay & Egan Co., of 212-232, West Front St., Cincinnati, Ohio.

Non-Cross Thread Couplings.

ALMOST as important as the fire hose employed for the protection of manufacturing establishments, private dwellings and public fire service are the couplings used in connection with it. The non-cross thread couplings manufactured by the Eureka Fire Hose Company, 13 Barclay Street, New York City, have been adopted as standard and are made with unusual care and such improvements in details of construction as to render them the very best possible, for hard and reliable service, and for facility in making connections All Eureka couplings are manufactured of bronze and unless otherwise desired all the threads are of the non-cross variety; that is, they are cut off at the outer end to facilitate coupling and to prevent any possibility of the threads being crossed when the hose connection is being made.

The Eureka couplings are cast entirely from new metals and are made exclusively of electrolytic copper and high grade tin, with only such admixture of spelter and lead as is necessary to best adapt the metal to coupling manufacture. Even those used on the cheaper grades of mill and linen hose are made entirely from the same high-grade new metals with a larger proportion of spelter, but the result is a strong and excellent metal for the purposes used. Many other hose couplings are cast entirely from old or second-hand metal, or are chiefly composed of such metal, and as a result castings are likely to be porous or weak or otherwise defective. It is impracticable when miscellaneous castings are melted up for the foundryman to know the

composition of the metals that is being used, or to adjust his processes to suit the composition cast.

The foundry of the Eureka Fire Hose Company at their factory in Jersey City, N. J. is a model one, and the coupling finishing department is equipped with the most modern machinery and appliances. No piece work is done in either foundry or finishing department, all the bronze and brass goods being made by day's work and under careful and expert supervision.

"Eureka" couplings are made with threaded swivels, which consist of four annular threads cut male and female in the inner and outer parts of the swivel respectively. These threads are standard 60 degrees and of full depth and give at least four times the wearing surface that the ordinary flanged lip swivel joint gives, and their V shape prohibits any possibility of jamming, as the tendency of the joint it to free itself. The threads, swivel, washer recess and water-way of the Eureka couplings are made at one setting of the part in a lathe and are consequently perfectly true with each other, and the couplings therefore go together without the slightest trouble. All swivel lugs are carefully milled to a uniform size so that spanners may invariably fit. The hose sockets are made of ample length to permit the use of an expansion ring of good width, and so avoid any liability of couplings blowing off, which is not unusual when short sockets and narrow rings are used.

A usual method of applying couplings is to have couplings sockets made so light or soft that they will readily expand when pressure is applied, then when couplings are being applied to the hose expansion is applied until the coupling itself begins to show expansion, when it is stopped without any definite knowledge as to whether sufficient pressure has been applied or not to cause coupling to withstand high service pressure. "Eureka" sockets are made heavy enough, and of such tough metal that ordinary expansion will not expand the sockets at all. Rings are expanded by the use of an hydraulic coupling machine, in which the amount of expansion pressure is recorded by hydrostatic gauges. The pressure required to affix the coupling so as to withstand high pressure is predetermined and when couplings are being affixed that prescribed pressure is applied. If the coupling socket is weak or defective it is liable to give out before such pressure it attained, but "Eureka" couplings are made expressly to permit the use of adequate expansion pressure without the slightest injury. Although the Eureka Fire Hose Company employ a special hydraulic expander as described, its couplings can be attached with any ordinary expander without the use of any special appliances such as many of the so-called "patent" couplings require.

Mechanical Time Recorders.

TO fill the continued and increasing demand for an instrument which makes a graphic record of variations of mechanical movements and the time of such variations, the Bristol Company, Waterbury, Conn., have placed on the market the instrument to which they have given the name mechanical time recorder.

A circular chart revolves by clockwork at uniform speed, while the pen moves an amount proportional to the motion to be recorded. The chart is 8 inches in diameter, being the same size as on the standard Bristol gauges.

Clock movements can be supplied for

complete revolution of chart once in 15 minutes, 1 hour, 2 hours, 3 hours, 4 hours, 6 hours, 8 hours, 10 hours, 12 hours, 24 hours or 7 days. Thus it will be seen that the speed may be selected to give best results under all commercial requirements.

The pen arm is rigidly attached at its lower end to a shaft which is turned by a short arm projecting through a slot in bottom of the case. The lever projecting to the right, is clamped to the short arm by a thumb nut. Special attention is called to the fact that this lever is adjustable and can be clamped to the arm at any convenient angle. The motion to be recorded after being properly reduced, if necessary, is imparted to the lever which in turn transmits it to pen.

The total scale on the chart is usually taken proportional to the total motion to be recorded. Reduced motion if necessary, can easily be arranged by the aid of pulleys, levers or other reducing devices.

Fine adjustments can readily be made by applying the motion at the proper point along the lever, and to facilitate this, a metal attachment is provided, which is adjustable on the lever arm, and secured in any position by thumb nut. It will readily be seen that by the aid of the adjustable lever arm and the adjustable slide on the arm XX the instrument is most conveniently adapted to record motions of all amounts and directions. Total deflection of the pen is obtained by turning the lever through an angle of about 12 degrees or 5 seconds motion at its outer end.

This instrument can be used to record the rate of motion and position of sluice gates, turbine or engine governors, gate valves, etc It is also adapted for recording the rise and fall of liquids in tanks, rivers, reservoirs and fore bays. In the gas industry it can be used to check up the operators and thus prevent the "blowing" of the holders either day or night. Its applications are, however, so many and varied that it is difficult to mention them even for a single industry. Any further information desired will be furnished by the manufacturers on application.

An African Conveyer Installation.

THE cyanide process whereby gold is primarily separated from loose sand and rocks, in which it is naturally found in minute particles, consists of tanks for chemically treating the whole mined product and means whereby the residuum of sand and rocks is disposed of after chemical separation of the gold. Where this process is carried on to the extent of hundreds of tons of materials a day many tanks of great dimensions are required, combined with conveying machinery whereby the raw material is not only handled to the tanks but the residuum of sand and rocks is also carried to waste places where in a very short time it accumulates to piles of great magnitude. This applies particularly to the gold fields of South Africa where the cyanide process is much used, and especially to the largest known plant of its kind,—the recently built joint plant of the Knights Deep, Ltd., and Simmer & Jack East, Ltd., Companies. In the combining of these two plants much rearrangement of old material and new conveyers were furnished by the Jeffrey Mrg. Co., Columbus, Ohio.

In the joint plant a space 170 x 470 feet is occupied by forty tanks, each forty feet in diameter by nine feet deep, arranged in four rows of ten tanks each, and known

as treatment tanks. Over these tanks are situated sixteen similar tanks known as collecting tanks which are placed concentric with treatment tanks Nos. 4, 5, 6 and 7 of each row. Over the treatment tanks and below the collecting tanks there are four 20 inch rubber belt conveyers, one over each row, driven by separate motors. These conveyers distribute the material from tanks above to those below as material is ready to be treated. Beneath each of the four rows of treatment tanks and directly under the four conveyers, there are four 20 in. belt conveyers each 426 ft. centers, running over three pulley trough-

ing idlers, 4 ft. centers. To these conveyers are fed residuum of sand and work through a small opening in the corner of the bottom of each tank, and they carry same to one end of the rows of tanks, delivering it to two cross belt conveyers at right angles to ends of the first four conveyers. These cross conveyers face each other, the first carrying the refuse from the first and second of the tank conveyers to the head of the third tank conveyers, while the second cross conveyer takes the four tank conveyer material to the same point, thus concentrating all the refuse at one point. The refuse being thus collected from the treatment tanks at one point and on one level, it is then delivered to a 30 in. rubber belt conveyer which in carrying the refuse on 310 ft. centers, elevates it 20 ft. into a 50 hp motor house at the head of the conveyer and at the foot or edge of the dumping grounds, as shown in the accompanying illustration.

At this point the material is delivered to the 8th and longest belt of the system, a 30 in. 6 ply, $\frac{3}{16}$ in. rubber covered Century belt 430 ft. centers, which carries the refuse to top of dump or refuse hill, as shown in illustration, a difference of elevation of 122 ft. from the first four conveyers under tanks. Having reached the top of the refuse hill, the sand and rock are delivered to the 9th conveyer, of the same make as the incline conveyer, except that it is now but 125 ft. on centers and is built on a horizontal portable wood frame, thus making it possible by the gradual shifting of this frame, in the extension of the conveyer head from the incline conveyer, besides the moving of same in an almost complete circle about the head of incline conveyer, to gradually build a plateau out from the top of the original hill or pile. As the work of moving this portable conveyer is too cumbersome a work to perform daily, there is placed at the head of this last conveyer what is known as a distributing boom of two 36 in. belt conveyers, all self-contained within a portable steel frame or structure. The first of these conveyers is merely a 30 ft. extension or advance of the last conveyer shown in the upper left hand corner of the illustration, while the second conveyer of the boom on 56 ft. centers is placed in boom at right angles to and back of the advance belt. This last boom conveyer is on rollers in the steel frame so that it can distribute material 56 ft. to either the right or left of the structure, being fed through a three-way hopper capable of placing the material to advance belt or to the right or left on the cross belt. In time it is intended to extend the 9th conveyer, feeding boom, from 125 ft. to 450 ft. centers. Thus it can be seen that with the present dump conveyer system, a plateau an eighth of a mile in diameter and 120 ft. high may be built before it will become necessary to change the present system of conveyers leading to the top of the refuse hill.

THE Stanislaus Electric Power Co., through its working company, The Union Construction Company, has just closed contract for an electric power transmission scheme of extreme importance to California industries. The site of the proposed plant it at Vallecite on the Stanislaus River near Angels Camp, Cal., and the scheme contemplates the utilization of the waters of the Stanislaus River, transmitting the power electrically to San Francisco, and incidentally tapping the Southern Mines and the upper San Joaquin Valley.

The operating head is 1,400 ft., equivalent to a pressure of 608 lbs. per sq. inch. The present equipment calls for three 6,700 kw, 400 rpm, General Electric generators, each of which will be driven by a Pelton water wheel unit of 12,000 hp capacity. Not only are the individual units larger than heretofore attempted, but the capacity of the station in excess of 36,000 hp is greater than any existing at the present time.

The only instance approaching this in impulse water wheel practice is the plant of the Puget Sound Power Co., at Electron, Wash., in which are installed four Pelton wheel units, each driving a 3,250 kw generator, with a combined maximum capacity for the station of 30,000 hp.

The units for the Stanislaus plant will be of the "double overhung" construction, characteristic of Pelton design for high power practice. Each unit will consist of two Pelton wheels, each overhanging the opposite end of a heavy shaft which carries the rotor of the generator in the center. Some details of construction covering these immense units may be of interest. The wheels proper each consist of a cast

steel annealed disc center to which are attached the Pelton buckets, also of cast steel. The buckets will be secured to the center by means of turned steel bolts hydraulically pressed into reamed holes—a novel point in water wheel construction. The shaft will be of fluid compressed hollow forged nickel steel, 28 ft. in length, 20 in. in diameter at the center where the rotor is located, and 16½ in. at the water wheel journals. The wheels and rotor will be designed for a press fit on the shaft at 100 tons pressure. The journals, one on each side of the generator, will be larger than any heretofore designed for this class of work, being 16½ in. diameter by 60 in. long. They are of the ring oiling, ball and socket type, water jacketed and provided with an oil pressure and gravity feed lubricating system. Also there will be furnished electric thermostats and indicators to give warning of any excessive rise in temperature. The nozzles will be of the needle deflecting type, admitting of close regulation and water economy, and are of cast steel, as are also the gate valves. These latter will be of the single disc Pelton type with phosphor bronze seats ground in place. They will be provided with roller bearings to relieve the thrust on the stems and will be actuated through gearing by means of small Pelton motors. At the switchboard will be located the main pilot control, by means of which the operation of gates, nozzles and needles may be under the immediate control of the station attendant, small Pelton motors and direct acting plungers being employed for this purpose. All pressure parts on these units are to be subject to a cold water test of 1,200 lbs. per square inch in the shops before shipment. The equipment will represent the highest development in hydro-electric transmission, and the installation is looked foward to with the greatest interest by engineers generally.

This contract is under the direct supervision of the engineering firm of Sanderson & Porter, New York, the complete hydraulic equipment being furnished by the Pelton Water Wheel Co. of San Francisco, and the electrical apparatus by the General Electric Co. Indications are that the year 1907 will eclipse its predecessor in the development of hydro-electric power transmission. The marked tendency is towards high speed, large power units. For example, the California Gas & Electric Co. is installing a Pelton wheel of 10,500 hp maximum capacity. The Telluride Power Co. of Colorado is adding to its equipment one 5,000 hp Pelton wheel operating under a head of 900 ft. and one 4,000 hp Pelton wheel under 1,800' head.

NEWS SUPPLEMENT

The Engineering Magazine—February, 1907

Personal.

—James Clayton, who was one of the pioneer manufacturers of air compressors, died recently at his home in Brooklyn.

—J. N. Duntley, president of the Chicago Pneumatic Tool Co., sailed for Europe on January 8, for the purpose of closing up several contracts for pnenmatic tools and appliances.

—William J. Clark, general manager of the foreign department of the General Electric Co., was appointed by Governor Hughes of New York, as a delegate to the national convention for the extension of the foreign commerce of the United States, held at Washington, D. C.

Industrial Notes.

—Warner & Swasey Co., Cleveland, have opened a New York office in the Singer Building, 149 Broadway.

—The Kobbe Co., publishers of *Compressed Air* announce the removal of their offices to 108 Fulton St., New York.

The International Steam Pump Co. has been compelled, by the steady advance in the cost of raw materials, to increase the prices of its products.

—James Stewart & Co., Chicago, have purchased for installation in the Veigo Elevator at Terre Haute, a 24 in. by 48 in. heavy duty engine to be built by the Allis-Chalmers Co. at its West Allis Works.

—The Breithhaupt Leather Co., Penetang, Ont., is installing two complete hot blast apparatus furnished by the B. F. Sturtevant Co., Boston. One is for the beam house and the other for the sole leather dry house.

—The Piqua Blower Co., Piqua, Ohio, is being incorporated under the laws of Ohio with a capital of $50,000. This corporation will take over the interests of the Pipua Foundry & Machine Co., Piqua, and will make a specialty of positive blowers and gas exhausters.

—The January number of the Budget, a paper published monthly by the Maryland Casualty Co., Baltimore, contains a letter by John S. Stone, president, in which he reviews the operations of the company for the year 1906 and casts a forward glance into the year 1907.

—The B. F. Sturtevant Co., Boston, is furnishing induced draft apparatus for large boiler plants at Nevada Consolidated Copper Co., McGill, Nevada; Alton Paving Building & Fire Brick Co., Alton, Ill.; Seattle Cedar Lumber Mfg. Co., Seattle, and Elliott Machine Co., Baltimore.

—The Power and Mining Machinery Co., of Cudahy, Wis., in conjunction with The Snow Steam Pump Works, Buffalo, has opened a sales office at 719 White Building, Buffalo, where will be handled the several types of gas generating apparatus, and the Snow gas engines.

—Among recent orders received by the B. F. Sturtevant Co., Boston, for electric propeller fans may be enumerated, Swift & Co., Jersey City; Alexander Dept. Store, Boston; Hagerty Bros., Peoria; Wallace, Stebbins & Sons, Baltimore, and Russell & Erwin Mfg. Co., New Britain.

—The Lunkenheimer Co., Cincinnati, has purchased from Allis-Chalmers Co., seven 60-cycle-induction motors ranging in size from 7½ to 15 hp to be used in driving machinery for th manufacture of valves and other enginering specialties. These motors will be built by Allis-Chalmers Co. at its Cincinnati Works.

—Julius Andrew Arce, Arequipa, Peru, has in charge the construction of the Goyeneche Hospital and the Southern Peru State Jail. Both are steel and masonry constructions to cost $200,000 and $150,000 respectively (American Gold). Roofs will be reinforced concrete. In connection with both works a complete quarrying plant will be imported immediately.

—Among recent contracts taken by the B. F. Sturtevant Co., Boston, for complete heating and ventilating systems in manufacturing plants are included American Locomotive Co., Dunkirk; Sutro Bros. Braid Co., West New York, N. J.; Massy-Harris Co., Brantford, Ont.; W. C. Edwards Co., Ltd., Ottawa, Ont.; and Camden Anchor-Rockland Machine Co., Camden Me.

—Jones & Naumburg, New York, who recently replaced the shafting and belting in their factory, at 515 West 25th Street, by individual motor-drive, have purchased from Allis-Chalmers Co., Milwaukee, a new electric generating unit consisting of one reliance engine driect connected to a 200 kw generator. The latter will furnish direct current, at 240 volts.

—Undergrate and forced draft apparatus is being installed by the B. F. Sturtevant Co., Boston, for the following: P. Ballantine & Sons, Newark; Atlas Engine Works, Jersey City; Haverhill Gaslight Works, Haverhill, Mass.; Lawrence Mfg. Co., Lowell; Newton, Langhorne & Bristol St. Ry. Co., Newton, Pa.; and Arlington Mills, Lawrence, Mass.

—The Lloyd Mfg. Co., Minneapolis, have ordered from Allis-Chalmers Co., twenty-three induction motors ranging in size from 2 to 15 hp which are to be installed for operating the machinery in their plant. Power will be furnished by an alternating current generating set previously purchased from Allis-Chalmers Company. The motors are used to run at speeds ranging from 1,200 to 1,800 rpm.

—Among the recent generator sales of the Crocker-Wheeler Co., Ampere, N. J., are the following: Waynesboro Electric Light & Power Co., Waynesboro, 1-300 kw engine type ac generator 2300 v 164 rpm 60 cycle. Republic Iron & Steel Co., Youngstown, 1-200 kw engine type dc generator 250 v 100 rpm. Interstate Iron & Steel Co., E Chicago, 1-225 kw engine type dc generator 250 v. Chas. C. Morse & Co., San Francisco, 1-200 kw ac generator 2300 v 60 cycle and 1-13 kw generator 125 v 950 rpm as exciter. Williams Construction Co., Corinth, Miss., 2-150 kw engine type ac generator 3 phase 2,300 v 225 rpm. Trimont Mfg. Co., Roxbury, 1-100 kw belt type ac generator 240 v 600 rpm. Crown Seal & Cork Co., Highlandtown, Baltimore, 1-150 kw dc generator 125 v 225 rpm.

—The Babcock & Wilcox Co., has bought from The Stirling Consolidated Boiler Co., as of December 31, 1906, its

American property and interests, including all accounts and bills-receivable, and has assumed its obligations and will execute its orders and contracts for boilers and appurtenances for installation and use in the United States. The plants thus purchased will be operated in the future by The Babcock & Wilcox Company under the name and style of "The Babcock & Wilcox Co., (Stirling Department)," and will be operated under the direct charge and management of the same gentleman who have operated The Stirling Consolidated Boiler Co.

—The Crocker-Wheeler Co., Ampere, N. J., report among their recent sales the following motors and generators secured the latter part of 1906 for delivery in 1907: National Tube Co., McKeesport, 1-75 hp 230 v dc motors. Union Rolling Mills, Cleveland, 1-100 kw 250 v 250 rpm dc generator. Peoria Stone & Marble Co., Peoria, 1-200 kw 250 v 115 rpm dc generator. Ford Morocco Co., Wilmington, 1-100 hp dc motor 500 v. Union Gas & Electric Co., Cincinnati, 3-35 hp 240 v dc motor for driving ventilating fans. Bethlehem Steel Co., 1-500 kw dc motor 240 v 450 rpm. Schlather Brewing Co., Cleveland, 2-25 hp 220 v dc motors 550 rpm. Ellsworth Coal Co., Ellsworth, 1-50 hp and 1-15 hp 230 v dc motors. Stone Ptg. Co., Roanoke, Va., 49 motors ranging from ¼ to 100 hp.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

INGERSOLL-RAND Co., New York.—Catalogue No. 36 illustrating and describing air and gas compressors for all duties and pressures. Also contains many tables giving much valuable data. 6 by 9 in.; pp. 182.

Arc Lamps.

FELIX HAMBURGER, New York.—Small booklet containing a description of flaming arc lamps: also tables giving sizes. 3½ by 6 in.; pp. 16.

Assaying Materials.

F. W. BRAUN Co., Los Angeles.—Illustrated price list of assaying materials for smelters, mines, mills, assayers, colleges, etc. 6½ by 10 in.; pp. 504.

Boilers.

BUTMAN ENGINEERING Co., Chicago.—Circular No. 2 describes vertical steam boilers. Also contains testimonial letters from users. Well printed and illustrated. 7½ by 12½ in.; pp. 16.

Bolt & Nut Mchy.

H. B. BROWN Co., East Hampton, Conn.—Catalogue illustrating and describing bolt cutters, bolt headers, nut tappers, bolt pointers, etc. 9 by 6 in.; pp. 36.

Cable Cranes.

BALANCED CABLE CRANE Co., New York.—Pamphlet containing a description of the balanced cable crane, together with many views showing it in operation. 9 by 5 in.; pp. 42.

Cement.

LAWRENCE CEMENT Co., New York.—Booklet containing testimonial letters from users, together with reports of tests and directions for making tests. 5 by 8 in.; pp. 82.

Clay Working Machinery.

THE BONNOT Co., Canton, Ohio.—Catalogue containing an illustrated description of brick machines, automatic cutting tables, dry press machines, screens, etc. 10 by 7 in.; pp. 96.

Concrete Piling.

RAYMOND CONCRETE PILE Co., Chicago.—Pamphlet treating of concrete pile construction. Illustrated. 6 by 9 in.; pp. 48.

Counting Machines.

W. N. DURANT Co., Milwaukee.—Catalogue illustrating and describing the many uses to which these counters may be adapted. 9 by 6 in.; pp. 20.

Cranes.

NORTHERN ENGINEERING WORKS, Detroit.—Catalogue No. 20 is devoted to an illustrated description of cranes of many different types. 6 by 9 in.; pp. 100. Catalogue No. 21 treats of electric hoists. 6 by 9 in.; pp. 40.

Derricks and Engines.

ALLEN & ROSS, Philadelphia.—Catalogue showing a number of derricks and hoisting engines in operation. 9 by 6 in.; pp. 22.

Derrick Fittings.

DOBBIE FOUNDRY AND MACHINE Co., Niagara Falls, N. Y.—Catalogue No. 11 devoted to an illustrated description of standard derrick fittings, together with tables giving dimensions, prices, etc. 9 by 6 in.; pp. 96.

Drilling Machines.

BAUSH MACHINE TOOL Co., Springfield, Mass.—Well-printed catalogue illustrating and describing drilling machines, together with tables and dimensions. 5 by 7½ in.; pp. 30.

HOEFER MFG. Co., Freeport, Ill.—Catalogue K illustrates and describes drilling machines. Metal saw, boring machines, spring machinery, etc., are also treated. 6 by 9 in.; pp. 48.

Drills.

SULLIVAN MACHINERY Co., Chicago.—Catalogue No. 35 illustrates and describes diamond core drills, together with a price list. The catalogue is well printed. 6 by 9 in.; pp. 158.

Dump Cars.

KILGORE-PETELER CO., Minneapolis.—A number of circulars illustrating and describing steel frame two-way dump cars.

Electrical Goods.

WESCO SUPPLY CO., St. Louis.—General supply catalogue No. 100 illustrating and describing electrical goods, together with prices and other data of a valuable nature. 8 by 11 in.; pp. 824.

Emery Grinders.

CHALLENGE MACHINE CO., Philadelphia.—Catalogue containing a description, together with tables giving weights, dimensions, etc., of emery grinders. Illustrated. 6 by 9 in.

Excavators.

F. C. AUSTIN DRAINAGE EXCAVATOR CO., Chicago.—Pamphlet illustrating and describing drainage excavators, and also contains many views showing the excavator at work. 10 by 7 in.; pp. 16.

Gearing.

NEW PROCESS RAW HIDE CO., Syracuse.—Catalogue containing views of their factory and hide plant, together with illustrations of the different styles of gears manufactured. Also contains information in regard to noiseless pinions and methods of treating the hide for same. 3½ by 5½ in.; pp. 86.

Hoisting Machinery.

WASHINGTON IRON WORKS CO., Seattle.—Loose-leaf catalogue illustrating and describing logging engines and hoisting machinery for all purposes. 9½ by 11 in.

Journal Box.

T. H. SYMINGTON CO., Baltimore.—Pamphlet containing an illustrated description of journal boxes for all classes of car, locomotive and street railway equipment. 4½ by 10½ in.; pp. 36.

Locomotives.

AMERICAN LOCOMOTIVE CO., New York.—Catalogue illustrating and describing ten wheel type locomotives weighing less than 150,000 pounds. 9 by 6 in.; pp. 54.

LIMA LOCOMOTIVE & MACHINE CO., Lima, Ohio.—Catalogue treating of geared locomotives, together with tables giving dimensions. 9 by 6 in.; pp. 32. Also a pamphlet containing illustrations of locomotives recently built.

Meteorological Instruments.

QUEEN & CO., INC., Philadelphia.—Catalogue illustrating and describing thermometers, pyrometers, hydrometers, barometers and weather bureau apparatus, together with price lists, 6½ by 10 in.; pp. 172.

Mine Locomotives.

GENERAL ELECTRIC CO., Schenectady.—Well-printed and illustrated catalogue describing electric mine locomotives. Also Bulletins Nos. 4466, 4470 and 4473 treating rheostats, motors in saw-mill work and railway motors respectively.

Mining Machinery.

MORGAN-GARDNER ELECTRIC CO., Chicago.—Illustrated catalogue containing a description of mining machinery. 7 by 9 in.; pp. 112.

Miners' Supplies.

GALENA IRON WORKS CO., Galena, Ill.—Catalogue No. 1 contains illustrations, with brief descriptions of crushers and rolls, steam and electric hoisters, mining cars, air compressors, etc. 9 by 6 in.; pp. 126.

Motor Hoists.

INGERSOLL-RAND CO., New York.—Bulletin No. 2008 devoted to an illustrated description of motor hoists and stationary motors. 6 by 9 in.; pp. 32.

Numbering Machine.

BATES MFG. CO., Orange, N. J.—Small pamphlet illustrating and describing automatic hand numbering machines. 3½ by 6 in.; pp. 16.

Ore Cars.

GLOBE IRON WORKS, Stockton, Cal.—Catalogue devoted to an illustrated description of automatic ore cars. Also contains tables giving specifications. 6 by 9 in.; pp. 28.

Ore Smelting Equipments.

COLORADO IRON WORKS CO., Denver, Colo.—Catalogue No. 12 containing important notes and data in regard to modern blast furnace smelting. Illustrated. 6 by 9 in.; pp. 158.

Pavement.

MACK MFG. CO., Philadelphia.—Catalogue describing standard vitrified paving brick sand blocks, together with views showing streets on which this pavement has been employed. 9 by 6 in.; pp. 62.

Presses.

FERRACUTE MACHINE CO., Bridgeton, N. J.—Temporary catalogue No. 15 referring to nearly 500 kinds and sizes of foot and power presses. Illustrated. 4½ by 6 in.; pp. 40.

Pumps.

BLACKMER ROTARY PUMP, POWER AND MFG. CO., Petoskey, Mich.—Catalogue illustrating and describing rotary pumps, together with tables giving sizes, prices, etc. 6 by 9 in.; pp. 16.

Pyrometers.

WM. H. BRISTOL, New York.—Bulletin No. 7 treats of recording electric pyrometers. 9 by 12 in.; pp. 16.

Reinforced Concrete.

REID-TURNBULL CONSTRUCTION CO., Philadelphia.—Catalogue containing a description of reinforced concrete construction, together with views showing a number of buildings constructed of concrete. 9 by 7 in.; pp. 88.

UNIT CONCRETE STEEL FRAME CO., Philadelphia.—Booklet containing report of tests on the unit system of reinforced concrete as conducted under the supervision of the engineering staffs of the Building Bureaus of New York and Philadelphia. 6 by 9 in.; pp. 64.

Rock Crushing Machinery.

POWER AND MINING MACHINERY CO., Cudahy, Wis.—Catalogue No. 4 contains an illustrated description of machinery for rock-crushing plants. Catalogue No. 5 treats of gold and silver milling machinery. Catalogue No. 6 ill-

ustrates and describes machinery, furnaces and complete equipment used in roasting, smelting and refining for the recovery of the precious metals.

Rock Drills.

AMERICAN DIAMOND ROCK DRILL CO., New York.—Catalogue No. 26 containing an illustrated description of diamond pointed core drills, and special features, together with price lists and records of work. 6 by 9 in.; pp. 86.

J. GEO. LEYNER ENGINEERING WORKS CO., Denver.—Catalogue No. 7 illustrating and describing rock drills. 7 by 9 in.; pp. 32. Also pamphlets treating air compressors and hoisting engines and ore handling apparatus.

Roofing.

F. W. BIRD & SON, East Walpole, Mass.—Booklet describing paroid roofing, together with many views showing buildings on which this roofing has been used. 7 by 5 in.; pp. 28.

Roofing Slate.

GENUINE BANGOR SLATE CO., Easton, Pa.—Catalogue entitled "Slate and its Uses." describes the many advantages to be derived from the use of slate as roofing material. Also contains illustrations of many buildings on which this slate has been employed. 8 by 5 in.; pp. 72.

Roofing Tin.

AMERICAN SHEET AND TIN PLATE CO., Pittsburg.—"From Underfoot to Overhead" is the title of a well-printed and illustrated booklet describing the experience of a piece of ore from its home in mother earth to its place on the home of man. 7½ by 5 in.; pp. 62.

Steam Engines.

ROLLINS ENGINE CO., Nashua, N. H.—Bulletin No. 15 illustrating and describing automatic four valve engines. 9 by 6 in.; pp. 24.

IRONTON ENGINE CO., Ironton, Ohio.—Catalogue illustrating and describing the Allfree automatic and expansion engines. 9 by 6 in.; pp. 20.

ERIE MFG. & SUPPLY CO., Erie.—Catalogue B illustrates and describes self-oiling automatic engines. 9 by 6 in.; pp. 24. Catalogue No. 6 treats of feed water heaters. 6 by 9 in.; pp. 8.

WM. A. HARRIS STEAM ENGINE CO., Providence.—A descriptive catalogue of the improved Harris-Corliss steam engines. Also contains a list of users. Illustrated. 10 by 7 in.; pp. 66.

CHUSE ENGINE & MANUFACTURING CO., Mattoon, Ill.—Catalogue containing an illustrated description of self-oiling automatic engines for all purposes. 9 by 6 in.; pp. 32.

B. F. STURTEVANT CO., Boston.—Bulletins Nos. 141 and 142, descriptive respectively of vertical enclosed compound engines and of generating sets equipped with these engines.

ALLIS-CHALMERS CO., Milwaukee.—Bulletins Nos. 1503 and 1510 illustrate and describe direct-connected Reynolds-Corliss engines, "Reliance" and heavy duty pattern. Bulletin No. 1506 treats of electric hoists.

ATLAS ENGINE WORKS, Indianapolis.—Bulletin No. 134 briefly describes the many different styles of engines manufactured by them. Boilers are also treated. Illustrated. 8 by 10½ in.; pp. 24.

Steel Doors.

COLUMBUS STEEL ROLLING SHUTTER CO., Columbus.—Catalogue illustrating and describing steel rolling doors, shutters and partitions. 10½ by 7½ in.; pp. 30.

Steel Office Fixtures.

VAN DORN IRON WORKS CO., Cleveland.—Catalogue No. 60 illustrating and describing metallic furniture, filing devices and fixtures for corporations, public buildings, banks, etc. 10 by 7 in.; pp. 42.

Taps and Dies.

BUTTERFIELD & CO., Derby Line, Vt.—Catalogue containing an illustrated description and price list of taps, dies, screw plates and reamers. 6 by 9 in.; pp. 84.

Telephones.

DE VAU TELEPHONE MANUFACTURING CO., New York.—Booklet illustrating and describing telephones for use in factories, office buildings, hotels, etc., together with price list. 5 by 7¼ in.; pp. 56.

Time Recorders.

DEY TIME REGISTER CO., Syracuse.—Well-printed catalogue containing an illustrated description of the Dey time register. 5½ by 8½ in.; pp. 36.

Traction Engines.

BEST MANUFACTURING CO., San Leandro, Cal.—Catalogue illustrating and describing traction engines for all purposes. 10 by 7 in.; pp. 32.

Valves.

JENKINS BROS., New York.—Catalogue and price list of valves, packings, discs, pump valves, etc. Illustrated. 6 by 9 in.; pp. 128.

Voltage Regulators.

GILMORE ELECTRIC CO., So. Boston.—Catalogue illustrating and describing automatic voltage regulators for all classes of work, together with diagrams and instructions. 6 by 9 in.; pp. 12.

Watchman's Watch.

NEWMAN CLOCK CO., Chicago.—Leaflet illustrates and describes a portable watchman's clock, together with a list giving prices.

Water Tube Boilers.

A. D. GRANGER CO., New York.—Bulletin No. 2 illustrates and describes water tube boilers. 9 by 6 in.; pp. 28.

Well Drilling Machinery.

CROWN DRILLING MACHINE CO., Akron.—Catalogue C illustrates and describes portable well drilling machinery. 6½ by 10 in.; pp. 64.

Wrenches.

BEMIS & CALL HARDWARE & TOOL CO., Springfield, Mass.—Illustrated catalogue containing a description of wrenches of different styles. Also a price list. 6 by 9 in.; pp. 16.

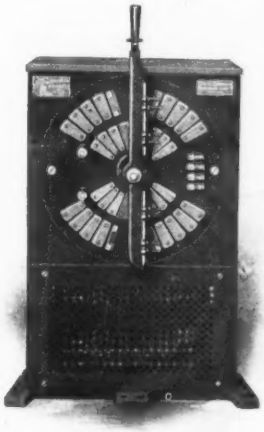
IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

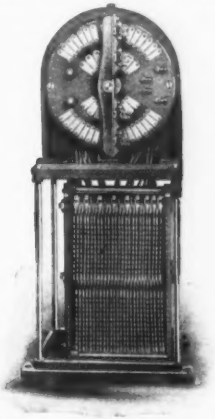
A New Line of Controllers.

THE Electric Controller & Supply Co., of Cleveland, Ohio, are placing upon the market a new line of controllers termed Type G which have a rating of 1 to 50 H. P. These controllers were built to meet the requirements of general crane service where the conditions are not severe enough to demand the use of the Dinkey ventilated controller. The Type G-3 and G-4 controllers are built with coil resistance and the Type G-5 and G-6 controllers are built with cast grid resistance. When it is desired to place controllers above or in the



TYPE G-5 CONTROLLER, FRONT VIEW.

rear of the operator the Type G controller is furnished arranged for under lever operation. They are also furnished with spring return for operation from the floor by means of pendent ropes or chains. A number of crane users have decided that a 15 or 20 ton crane requiring a 25 or 30 horse-power motor on the hoist and bridge motion may be operated from the floor by any of the men in the shop, thus saving the wages of a crane operator who would probably be idle half his time. It is a very simple matter to put cutouts at either end of the trolley travel and at either end of the runway to prevent accident. The Type G controller meets this demand for a controller up to 50 horse-power arranged for operation from the floor by means of ropes. This controller is a self-contained unit, the resistance being placed in the frame, making it necessary to run only four wires between the controller and motor. Reversal is accomplished by the use of a single lever, no separate reverse switch being required. The Type G controllers are self-contained, compact, and accessible. All parts are made to jig and are interchangeable. The contact face is of heavy slate, free from metallic veins. The contact segments are of copper which are screwed to brass lugs to which all wiring connections are made. By this construction any of the contact segments can be removed and replaced without disturbing the wiring connections. The contact



TYPE G-6 CONTROLLER, FRONT VIEW, ALL CASES REMOVED SHOWING RESISTANCE AND FACE OF CONTROLLER.

arms is of soft cast iron and carries the fingers and finger holders, the insulation of

which is of heavy pressed vulcabuston bushings. The contact fingers are of dropped forge copper of great hardness and may be removed and replaced without removing the contact arm. A powerful and effective blow-out is provided in all sizes of these controllers. The frame for Type G-3 and G-5 controllers consists of a main casting in one piece provided with a cover, the removal of which affords easy access to all resistance connections. The case enclosing this frame is of perforated steel, thus allowing ample ventilation. The frame of the G-4 and G-6 controllers consists of a bottom casting which supports the resistance, and a top casting which supports the contact slate and arm. The top and bottom casting are connecting by means of four steel corner posts around which a casing of perforated steel is provided for ventilation and protection to resistance. The top casting of the G-4 and G-6 controllers supports the contact slate which is completely covered and protected by a sheet steel casing. This protects the operator from coming in contact with any live parts of the controller, and also protects the working parts of the controller from dust and dirt. Easy operation is secured by a lever which is keyed to the arm shaft at the back of the top casting, which gives a short movement of about 10 inches in either direction for both starting and reversing. The resistance for the G-5 controller is built of cast grids in a single bank which may easily be removed as a unit without disturbing the other parts or moving the controller. The resistance for the G-6 controller is made of two banks supported on bars attached to the frame, and may be removed in separate units without disturbing the other parts. The resistance for Type G-3 and G-4 controllers is made up of Type E coils which consist of a heavy asbestos tube stiffened by means of a central brass tube which serves to bring the rear terminal forward, facilitating the necessary connections. These controllers are very adaptable for service up to 500 volts. Six points of control are provided with the G-3 and G-5 controllers, and eight points of control with the G-4 and G-6 controllers.

The Cone Gas Generator.

THE Cone gas generator, using bituminous coal, and now manufactured for the United States by the Cone Gas Machine Co., Detroit, occupies a field entirely its own by its revolutionary improvements in the generation of gas. Until this machine was demonstrated it has been considered impossible to use bituminous coal in a gas generator without the formation of tar, requiring the addition of expensive auxiliary machinery to remove or burn it, which made it impractical in most power plants. The Cone vacuum process entirely removes this difficulty, and not only does not form tar, but preserves in a fixed gas the ethylene and methane series (the highest heating gases yielded by the coal) which in all other soft coal producers are destroyed by destructive distillation. The process employed in the Cone generator is an entirely new departure in gas making, and really combines in one the three known methods of securing gas from coal, viz., (1) distillation by which the volatile hydro-carbons are driven off as in illuminating gas; (2) the water gas process in which the elements of water H_2 and O are dissociated in the presence of incandescent carbon, the element O uniting with carbon to form CO and the element H being set free; (3) the air gas process by which the O of the air forced through the incandescent fuel unites with the free carbon to form CO or carbon monoxide, the well known fuel gas,—thus utilizing all the available heat obtainable from the coal, and leaving nothing but ash as a waste.

This seemingly complicated process is, however, simplicity itself in its application and when understood. Its method may be explained as follows: The fuel is divided into two zones called the primary or lower zone and the secondary or upper zone. The coal is introduced at the top and passes through the different processes of distillation, until by the time it reaches the primary zone it is coke. The coke in this zone is exposed to air only, admitted through the rose in the center, and keeps this part of the fuel at incandescent heat continually whether the generator is run-

ning on full load or on no load. The vaporizer located between the primary and secondary zones, supplies large quantities of steam at this point and thereby retards combusion of the coal above, sufficiently to prohibit destructive distillation of the higher volatiles which pass off in a fixed gas. The union of the elements to form tar is prevented as follows: (1) by the excessive amount of steam introduced and (2) by coming in contact with the cooler surface of the air and water heaters shown surrounding the reservoir at the top of the generator. The result of this process briefly stated is: (1) that it is entirely automatic, requiring no attention but to feed the coal and remove the ashes; (2) it gives a perfectly tarless gas of high calorific value; *(3) while the fuel is passing through the different stages of distillation the heat is too low to make clinker, but when the coke reaches the primary zone it is too well digested to form anything but small clinker which passes out freely with the ashes; (4) the machine will always respond instantly from no load to full load, as a high heat is always maintained in the primary zone and increases the output of gas the moment the suction is increased; (5) it yields a gas from cheap bituminous coal or lignite, greatly exceeding in heat value the gas obtained from the more expensive anthracite.

Many well known gas engineers have made exhaustive tests of this machine and are enthusiastic in its praise; space prevents the insertion of these tests, but they can be obtained by addressing Cone Gas Machine Co., Detroit, Mich.

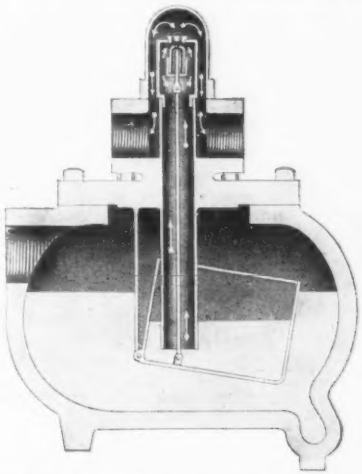
*Gas made in the Cone producer from Pocahontas coal, tested by means of the Junker calorimeter showed it to have a heating value of 213.5 B. T. U. per cubic foot at 0° and 760 m-m barometer pressure. It had the following composition:

CO_2	C_2H_4	O_2	CO	H_2	CH_4	N_2
5.0	2.0	1.0	12.8	18.1	8.4	52.7

Testing a Steam Trap at High Pressure.

THE accompanying photograph shows a new Squires steam trap operating at 375 pounds pressure in a test made by its inventors, C. E. Squires and Benjamin Silliman of Cleveland, Ohio. The trap has just discharged, throwing out 241 cubic inches of water in less than one second. The impression that steam is escaping with the water is erroneous. Steam does escape from some traps, but usually as a result of wire-drawing between the periods of water discharges. The appearance of steam in the photograph is due to the fact that vapor "takes" in a photograph as steam and that part of the water discharged at high temperature and pressure flashes into steam instantly on being liberated. In this instance very little moisture came down, all having been converted into vapor before there was time to reach the ground.

The unusual method of supplying steam used in testing these traps was adopted because there were no high pressure boilers available, the Cleveland Electric Illuminating Company with a maximum of 165 pounds offering the next highest steam pressure in the city. The automobiles are



1906 model White steamers equipped with feed water heaters. Their running pressure varies from about 150 to 450 pounds at the steam chest of the engines. The boiler pressures are much higher, the safety valve usually being set between 1,000 and 1,200 pounds. In these tests the safety valves were set for 750 pounds.

After subjecting the trap to 1,000 pounds per square inch hydrostatic pressure at the factory, it was connected to the automobile as shown, so that steam at various pressures entered from the boiler of the machine on the right, and heated water at similar pressures entered from the feed

pump of the one on the left. Water could then be turned into the trap in any quantity, taking the place of condensation in ordinary service.

Steam alone was admitted to the trap at first until the gauge indicated 600 pounds, the pressure which was maintained for some time to test the gaskets. These are vital parts in high pressure work, as they must be unaffected by the moisture of saturated and the heat of superheated steam, and as the joints must come apart easily for inspection of the trap interior. In this test the joints remained perfectly tight. The packing used was a special corrugated copper gasket, which, in addition to meeting the requirements mentioned, does not deteriorate if the joint is taken apart often. A feature of the trap tested adapting it to high pressure work is the placing of the joints entirely above the water line. Traps having the main joint partly in contact with steam and partly with water will do on medium pressures, but, owing to the widely varying temperature of the contained water and steam at high pressure, begin to leak from the effect of unequal expansion. A second test was made to find the highest pressure at which the trap would operate.

The following short description, in connection with the cross-sectional view of the trap will enable the reader to understand the manner in which the trap works. Its action depends upon the buoyancy of a cast iron bucket hinged on cone bearings at one side and connected to the valve mechanism by a similarly hinged brass rod. The proportions of the bucket and the location of the valve rod are such that at atmospheric pressure the bucket when submerged exerts a pull of six pounds on the valve rod. In practice when condensation has reached the high water line the bucket fills, sinks and opens an auxiliary valve which is ⅛ inch in diameter. Pressure under the main valve is thus relieved and it is pushed down and open instantly by the internal trap pressure upon its upper surfaces. The bucketful of water is then discharged, and the bucket on rising closes both valves until the operation is repeated. No wire-drawing is possible, as the valves are always wide open or closed tightly.

To keep the auxiliary valve (⅛ inch in diameter or .01227 sq. inch in area) shut against the pressure of 6 pounds pull on the stem from the bucket the steam must exert a pressure in pounds per square inch of 6 x 1/.01227 or about 490. These figures neglect the variation in density of water at high temperatures and conditions of motion within the trap. To prove these figures, enough water was pumped into the trap to cover the bucket, and by opening the air vent, the pressure was gradually lowered until the trap began to discharge. This did not occur until the gauge showed 375 pounds, a result which emphasizes the importance of service tests on steam apparatus when reliable data are required.

Additional water was continually pumped in and discharged at this pressure for ten minutes. The action of the valve was accompanied by slight vibration. The discharge sounded like the exhaust of a two-ton steam hammer and could be heard some distance. The pressure was further reduced to 300 pounds, and water pumped into the trap in a continuous stream. The valve action was smooth, and the trap proved itself capable of maintaining perfect operation for an indefinite period.

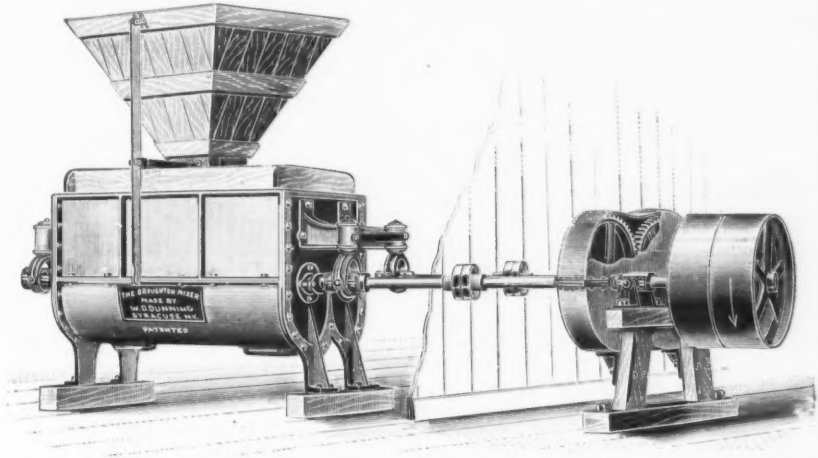
These tests should interest those who use steam at high temperatures and pressures, and high-pressure plants are increasing yearly. The Squires trap is made by Strong, Carlisle & Hammond Co., of Cleveland, Ohio.

The Broughton Mixer.

THE Broughton mixer, as shown by the accompanying cut, has been used successfully for mixing gun powder for a number of years. The same mixing qualities which have made it a favorite with the largest wall plaster manufacturers in the United States and Canada for the past fifteen years assert themselves equally well in mixing gun powder. The essential point in getting a perfect mixture is to have a mixer that will mix together light and heavy materials evenly, as when one material is heavy and the rest light the tendency in most mixtures is for the heavy to work to the bottom and the light to come to the top.

The Broughton mixer has two shafts running side by side through the mixing chamber which is circling at the bottom, and the mixing paddles are secured to the shafts at an angle in such a manner that, as the shafts rotate in opposite directions, the paddles on their upward movement towards the center of the mixing chamber lift the different materials from the bottom of the case. In so doing one set of paddles casts the materials toward one end of the case while the other set casts it in the opposite direction. This reverse action causes the various ingredients, whether light or heavy, to become thoroughly and uniformly mixed.

All parts of this mixer which come in contact with the powder are made of either brass or aluminium, to guard against explosion.



The American Typewriter.

THE American typewriter provides a medium priced business-like machine, of the type-bar style, with all the advantages of the regular type-bar machine, and the added advantage of a saving of about 1,200 small parts in the finished machine. This great saving in parts is accomplished by forging the key and the type on a single bar of steel—the key at one end and the type at the other. The

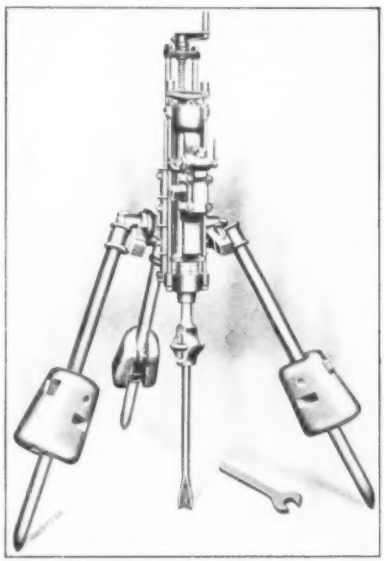
type bar, therefore, is only a simple lever, entirely free from complicated mechanism, and actually cannot get out of order. The weakness of the type bar action of typewriters is in the looseness which soon comes from the wearing of their joints. Some typewriters have as many as sixteen bearings between the key and the type, and some one of these is bound to work loose, spoil alignment and finally break down.

Of equal importance are the ball and socket bearings on which the type bars swing. This simple bearing insures freedom of action and minimum friction, and, consequently, light touch and high speed. The carriage and wheel escapement are mounted on ball bearings—the most approved aids to speed in typewriter construction.

The machine possesses the advantage of the insertion of special characters, such as fractions, accents, special marks, etc., in half a minute's time and changeability of carriage when that may be required. This typewriter possesses a number of other novel and exclusive features described in full in a pamphlet entitled "The American Way." The American Typewriter Co., 268½ Broadway, New York, will send it on request.

The Chicago Giant Rock Drill.

THE designing of a successful machine rock drill is an alluring proposition, calling for an intimate and practical knowledge of the conditions and ruggedness of service in which it has to operate and perform successful work. As it stands to-day, the machine rock drill represents an evolution of features of improvement, made necessary by a long line of demonstrations and failures in actual service. In the design and development of the machine shown in the accompanying illustration, the Chicago Giant Rock Drill, full advantage has been taken of the opportunities presented by embodying such features as have proved their fitness in successful service and combining them with improved features. Every detail has been given careful consideration as to its desirability, suitability of material and weight. Some of the improved features are—the shell which is of the adjustable type, constructed so as to provide for double side bearing for the cylinder; and the shell caps are so made that they will take up wear in two directions, horizontal and vertical, with one adjustment. A removal cylinder stop is also provided in the lower end of the shell. Its function is to prevent the cylinder from slipping out of the shell in case the feed screw should be run out of the feed nut. On the other hand, should it be desired to remove the cylinder from the shell, all that is necessary is to remove the stop first, then by turning the feed screw run the cylinder down in the shell until the feed screw is out of the feed nut; this



will allow the cylinder to be slipped out of the shell without any dismantling of the machine.

The cylinder is cast from a special mixture, having a tensile strength of 35,000 to 38,000 pounds and presenting a fine polished surface when finished. The upper end of the cylinder is extended to form a chamber for the rotating mechanism which is of the releasing type. Three parts are used, thus equally distributing the rotating effect and the pawls are constructed so that they are reversible; *i. e.*, should one of the engaging edges wear out, the pawl can be reversed so as to present the other and un-

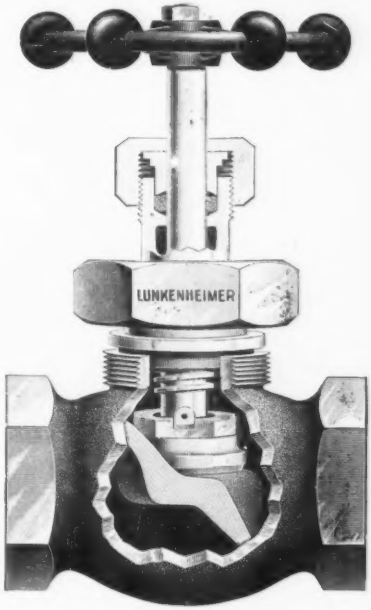
worn edge to engage with the ratchet. This is an important point, as it makes provision for doubling the life of each pawl. The ratchet is of one piece with the rotating or rifle bar, which is extended on its upper end to fit into a chamber or recess into the upper head; this provides for the holding of the rotating bar in a central position and relieves the rotating mechanism of all side strains. The valve motion is positive and is of the tappet or rocker type, modified to give a short stroke feature, the length of the stroke being at all times completely under control of the operator. The supporting pin of the rocker works in renewable steel bushings and is completely enclosed, it being kept in place by caps easily removable but which are securely locked in place by the valve seat when machine is assembled.

One of the most valuable features of the drill is the provision for automatic lubrication. An oil reservoir chamber is provided in the valve seat and communication is made between the oil reservoir and the interior of the valve chest. The oil is led through this channel into the chest where it mixes with the operating fluid and is carried by it into the interior of the machine. One filling of the oil reservoir will last half a "shift." In case the rotating mechanism should not receive sufficient lubrication from the interior, provision is made in the upper head whereby it may be oiled when necessary. Manufactured by the Chicago Pneumatic Tool Co., Chicago, Ill., who will send fuller details on request. The workmanship is of the best and absolute interchangeability of parts is assured.

Improved Regrinding Valves.

THE Lunkenheimer Co., Cincinnati, have made a number of desirable improvements on their regrinding valves. The changes, however, are not at all radical, as the valve has been in use for half a century and has proven itself to be of the correct design, having given general satisfaction wherever used. Its manufacturers, however, increased the weight of the valve, not because the thickness of shell, etc., were too light in their former products, but merely as an additional precaution against rough handling while attaching, etc. The medium pattern valves are guaranteed to stand a working pressure of 200 pounds per square inch and the extra heavy pattern up to 350 pounds per square inch. They have also altered the shape of the valve, which not only makes an elegant appearance but also increases the area through the valve, permitting an unobstructed passage through it, the area being more than equal to that of the connecting pipe.

To insure a perfect and strong joint between the pipe and valve, the pipe threads have been made considerably longer, thereby overcoming the danger of stripping threads which so often happens owing to rough and unskilled workmanship in attaching. All sizes of the valves now have



lock-nuts on the hand wheels, which facilitates the taking apart and assembling of the valve for repairs, etc. Referring to the sectional illustration, it will be noticed that the hub which carries the operating stem is secured to the body by a union connection which, in turn, screws over the shell of the valve body. By means of this construction it is impossible for the hub and the body to become corroded together, as

the thread which holds the union ring to the body is protected at all times from the action of the steam, the joint being made between the flange on the hub and the neck of the body. This connection also acts as a tie or binder in screwing over the body and tends to make the valve rigid and strong. The disc A is held loosely to the stem F by means of the lock-nut J, and therefore will adjust itself to the seat very readily and a tight joint can be relied upon. The stem F is fitted with a very strong, durable and long thread and the hand wheel is of ample diameter to insure the easy operation of the valve.

To regrind the valve, the bonnet ring is unscrewed and the trimmings are removed from the body. A wire or nail is placed through the lock-nut and stem, a little powdered sand or glass and soap or oil is placed on the disc and the trimmings are again placed in the valve and reground. The bonnet has a small rim or projection on the bottom thereof which acts as a guide on the inside of the valve neck while regrinding. The seats in the valve-bodies are very small when the valves are sent out from the factory, which permits of considerable regrinding and is considered an important feature.

The valve can be packed under pressure when open or closed and to pack while the steam is flowing through the valve, open it as wide as possible, when the shoulder at the top of the stem thread will form a seat beneath the stuffing box.

The material used is of the highest grade of bronze composition and the workmanship is in every respect commendable. Before being sent out, every valve is thoroughly tested and inspected, the stuffing boxes are packed and they are ready for immediate use.

The company have, in connection with their plant, a complete physical and chemical laboratory, which enables them to manufacture their products of such composition as are best adapted to withstand the chemical actions, strains, etc., to which the various products are subjected.

Gas Engine Designers.

ILLMER & CO., Fourth National Bank Building, Cincinnati, Ohio, have opened an office as gas engine experts, specializing in gas and oil engine design. By centralizing the design work they are not only enabled to deliver high class design at the least cost because of the saving effected in preliminary work, but at the same time the builder gets the benefit of highly specialized experience and is assured of the very best proportions of parts throughout.

NEWS SUPPLEMENT

The Engineering Magazine—March, 1907

Personal.

—Dodge & Day, Philadelphia, announce that John E. Zimmermann, formerly secretary of the American Pulley Co., has become a partner in their firm.

—American Steam Gauge & Valve Mfg. Co., Boston, advise that R. M. Turner, formerly their eastern representative, has been appointed manager of their publicity department and that C. H. Mosher has been secured to succeed Mr. Turner as eastern representative.

—Arthur Tomalin, formerly news editor of the Newark *Evening News*, has been appointed general advertising manager of the Central Railroad of New Jersey and editor of its monthly magazine "The Suburbanite," with offices at 143 Liberty Street, New York.

—Henry Clark Sergeant of the Ingersoll-Sergeant Drill Co., now an integral part of the Ingersoll-Rand Co., died at his home, Westfield, N. J., recently. Mr. Sergeant was a highly successful inventor, especially in the line of rock drills, air compressors and mining and excavating machinery in general.

Industrial Notes.

—Link-Belt Co., Philadelphia, have opened branch offices at 321 Ellicott Square Bldg., Buffalo, and 440 New York Block, Seattle.

—The Berlin Construction Co., Berlin, Conn., has received a contract for building an extension to the fan shop of the Green Fuel Economizer Co., Matteawan, N. Y.

—The B. F. Sturtevant Co., Boston, is installing for the Textile Machine Works, Reading, a complete emery dust exhausting arrangement consisting of steel plate exhaust fan and dust collector.

—The Century Cement Machine Co., Rochester, has just shipped six Hercules cement block machines to one contractor in Cairo, Egypt, for use in making concrete blocks for public building.

—The Curtis & Curtis Co., Bridgeport, manufacturers of Forbes patent die stocks, are compelled to enlarge their plant, and, in the early spring, will make a large addition to the machine shop, increasing their floor space by something over six thousand square feet, enabling them to about double the number of machines now employed in the manufacture of their pipe cutting and threading machines.

—The B. F. Sturtevant Co., Boston, has recently received orders for its high pressure rotary blowers from the General Fire Extinguisher Co., Atlanta.; Rivett Lathe Co., Brighton, Mass.; Wayne Agricultural Works, Goldsboro, N. C.; J. B. Clark Mfg. Co., Rockford, Ill.; N. Y. Continental Jewel Filtration Co., New York; Winchester Repeating Arms Co., New Haven; Salem Glass Co., Salem, N. J.; and Eastern Chemical Co., Boston.

—The natural draft system of cement burning, which uses very high stacks in order to get the draft, is being superseded by the compressed air apparatus made under the Hurry & Seaman patents, at the plants of the Leheigh Portland Cement Co. The natural draft system was the invention of Mr. Matcham, until lately the general manager of the company. President Trexler, of the Lehigh Company, states that, owing to the facts that the results obtained by the natural draft system did not show the anticipated savings, the Hurry & Seaman device was adopted.

—Buffalo Forge Co., Buffalo, have recently closed a contract with the West Virginia Pulp & Paper Co., Piedmont, Va. The equipment included fan, heater, ducts, rolling shutters, and Buffalo air washer, the latter to be constructed entirely of copper and is used to condense the moisture from the air as it is recirculated through fan, heater, and kiln. In order to condense the

moisture it is only necessary to cool the air from 140° to 100° at which temperature it contains so many more heat units than fresh outside air that a great economy is effected by recirculating the air through the kiln again rather than discharging it from vents and supplying outside air to the fan and heater.

—The Crocker-Wheeler Co., Ampere, N. J., has secured the following orders: Bridgeport Malleable Iron Co., Bridgeport, 1-200 kw direct current generator, 250 v. 208 rpm. 1-90 kw 250 v. 208 rpm direct current generator. Pittsburg & Baltimore Coal Co., Wendel, Pa., 1-300 kw direct current generator 575 v. 150 rpm. W. & J. Knox Net & Twine Co., Baltimore, 25-25 hp dc motors 230 volt 750 rpm. Bridgeton Electric Co., Bridgeton, Conn., 1-500 kw dc generator 550 v. 120 rpm. Alliance Machine Co., Alliance O., 74 motors ranging from 6 to 100 hp all of 220 volts. Bosches Troy Laundry, Austin, Tex., 14 motors ranging from ⅛ to 7½ hp 115 v. and 1-35 kw generator 125 v.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Belting.

DIAMOND RUBBER CO., Akron.—Catalogue illustrating and describing rubber belting. 5 by 7 in.; pp. 128.

Blacksmith Tools.

BUFFALO FORGE CO., Buffalo.—Catalogue 77 illustrating and describing, in addition to the regular line of tools, several new machines as well as changes and improvements in older designs. 3 by 6 in.; pp. 40.

Blowers.

EXETER MACHINE WORKS, Exeter, N. H.—Illustrated catalogue describing blowers, exhaust fans, ventilating wheels, and hot blast heating apparatus. 6¾ by 9 in.; pp. 32.

Boilers.

OIL WELL SUPPLY CO., Oswego, N. Y.—Well-printed catalogue illustrating and describing water tube boilers, together with several tables containing much valuable data. 9 by 6 in.; pp. 30.

Cement.

PENINSULAR PORTLAND CEMENT CO., Jackson, Mich.—Souvenir on the history, development and future of Portland cement. The pamphlet is well printed and handsomely illustrated. 8 by 11 in.; pp. 62.

ALMA CEMENT CO., Wellston, O.—Well-printed book showing their plants and also contains many views of structures on which this cement has been employed. 11 by 7 in.; pp. 100.

Cement Roofing.

PHILIP CAREY MFG. CO., Cincinnati.—Well-printed catalogue devoted to an illustrated description of flexible cement roofing. 6 by 9 in.; pp. 32.

Circuit Breakers.

CUTLER ELECTRICAL & MFG. CO., Philadelphia.—Cloth bound catalogue illustrating and describing circuit breakers. 8 by 11 in.; pp. 196.

Clutches.

AKRON CLUTCH CO., Akron.—Pamphlet containing an illustrated description of friction clutches. 6 by 9 in.; pp. 12.

Concrete Dams.

AMBURSEN HYDRAULIC CONSTRUCTION CO., Boston.—Catalogue illustrating and describing concrete-steel gravity dams. 7½ by 10½ in.; pp. 20.

Core Drills.

INGERSOLL-RAND CO., New York.—Catalogue No. 91 illustrates and describes Davis Calyx diamondless core drills. 6 by 9 in.; pp. 62.

Corrugated Sheathing.

WENDELL & MAC DUFFIE, New York.—Catalogue No. 16 illustrates and describes asbestos and cement fireproofing materials, including reinforced asbestos corrugated sheathing. 4 by 9 in.; pp. 24.

Crucibles.

R. B. SEIDEL, INC., Philadelphia.—Folder illustrating and describing black lead crucibles for melting steel, brass, bronze, gold, silver and other metals. 3½ by 6½ in.; pp. 4.

Cutter and Tool Grinder.

DAYTON MACHINE AND TOOL WORKS, Dayton.—Illustrated catalogue describing the operations of the universal cutter and tool grinder. 6 by 9 in.; pp. 14.

Drill Chucks.

JACOBS MFG. CO., Hartford.—Illustrated catalogue describing drill chucks. 9 by 6 in.; pp. 12.

PRATT CHUCK CO., Frankfort, N. Y.—Booklet illustrating and describing driving drill chucks, together with dimensions and prices. 3½ by 6 in.; pp. 18.

Electric Cranes.

CASE MFG. CO., Columbus.—Bullletin containing an illustrated description of electric cranes. 12 by 9 in.; pp. 32.

Electric Hoists.

SPRAGUE ELECTRIC CO., New York—Pamphlet illustrating and describing hoists and cranes. 4 by 8 in.; pp. 12.

Electric Tools.

CHICAGO PNEUMATIC TOOL CO., Chicago.—Illustrated catalogue describing electric drills, grinders, drilling stands, magnetic man-hoists, etc. 6 by 9 in.; pp. 60.

Emery Wheels.

HAMPDEN CORUNDUM WHEEL CO., Brightwood, Mass.—Catalogue and price list of emery wheels, corundum wheels and machinery. 4 by 7 in.; pp. 48.

Engineering Instruments.

YOUNG & SONS, Philadelphia.—Catalogue and price list illustrating and describing engineering and surveying instruments. 6 by 9 in.; pp. 140.

BUFF & BUFF MFG. CO., Boston.—A very complete catalogue illustrating and describing engineering and surveying instruments, together with price lists. 6 by 9 in.; pp. 118.

Feed Water Regulators.

CHAPLIN-FULTON MFG. CO., Pittsburg.—Catalogue illustrating and describing feed water regulators and other steam specialties. 6 by 9 in.; pp. 48.

Fire Hose.

EUREKA FIRE HOSE CO., New York.—Folder devoted to an illustrated description of fire hose.

Foundry Supplies.

FREDERICK B. STEVENS, Detroit.—Catalogue illustrating and describing foundry supplies, and facings and polishers and platers supplies. 6 by 9 in.; pp. 224.

Gang Drills.

MOLINE TOOL CO., Moline, Ill.—Catalogue illustrating and describing gang drills, screw drivers, head borers, bolt cutters, speed lathes, etc. 9 by 6 in.; pp. 16.

Gas Engines.

WESTERN GAS ENGINE CO., Los Angeles.—Catalogue containing an illustrated description of gas engines. Also contains tables giving much valuable information. 9 by 6 in.; pp. 62.

Gasoline Trucks.

KNOX MOTOR TRUCK CO., Springfield, Mass.—Catalogue giving specifications in detail of gasoline delivery cars and passenger conveyances. Illustrated. 8 by 5½ in.; pp. 20.

Gas Producers.

WELLMAN-SEAVER-MORGAN CO., Cleveland.—Catalogue illustrating and describing continuous gas producers. 6 by 9 in.; pp. 32.

AMSLER ENGINEERING CO., Pittsburg.—Catalogue devoted to an illustrated description of gas producers. 6½ by 8 in.; pp. 20.

MORGAN CONSTRUCTION CO., Worcester.—Pamphlet containing an illustrated description of continuous gas producers with automatic coal feeds. 4 by 9 in.; pp. 12.

Grinding Machines.

NORTON GRINDING CO., Worcester.—Catalogue devoted to an illustrated description of plain machines for cylindrical grinding. 9 by 6 in.; pp. 56.

NEW BRITAIN MACHINE CO., New Britain, Conn.—Leaflet illustrating and describing the new Whitney patent grinding and polishing machine. 6 by 9 in.; pp. 4.

Grinding Wheels.

NORTON COMPANY, Worcester.—Illustrated catalogue describing emery and corundum goods and grinding machinery. Also contains tables giving sizes, prices, etc. 6 by 9 in.; pp. 146.

Heating Machines.

ROCKWELL ENGINEERING CO., New York.—Pamphlet treating of oil or gas fuel heating machines for annealing, hardening, tempering, etc. 6 by 9 in.; pp. 8.

Hoisting Machines.

DOBBIE FOUNDRY & MACHINE CO., Niagara Falls.—Catalogue No. 15 illustrating and describing hoisting machines, derrick fittings, etc. 9 by 6 in.; pp. 264.

Industrial Plants.

D. C. NEWMAN COLLINS, New York.—Bulletin No. 21 is devoted to a brief description of the manner in which the erection of industrial plants is conducted. 5 by 7 in.; pp. 10.

Industrial Railway Materials.

ERNST WIENER CO., New York.—Catalogue No. 50 devoted to an illustrated description of railway materials for all industries. 8 by 11 in.; pp. 46.

Insulators.

LOCKE INSULATOR MFG. CO., Victor, N. Y.—Catalogue No. 9 illustrating and describing porcelain insulators. 6 by 9 in.; pp. 60.

Key-Seaters.

MITTS & MERRILL, Saginaw.—Catalogue devoted to an illustrated description of key-seaters and splicing machines. 6 by 9 in.; pp. 32.

Lathes.

R. K. LE BLOND MACHINE TOOL CO., Cincinnati.—Catalogue illustrating and describing lathes. Also a catalogue devoted to milling machines. 6 by 9 in.; pp. 92.

WALTHAM WATCH TOOL CO., Springfield, Mass.—Catalogue illustrating and describing bench lathes and bench milling machines. 9 by 6 in.; pp. 24.

LODGE & SHIPLEY MACHINE TOOL CO., Cincinnati.—Catalogue illustrating and describing lathes designed especially for using high speed steels. 9 by 6 in.; pp. 98.

Machine Tools.

GEO. D. WALCOTT & SON, Jackson, Mich.—Catalogue illustrating and describing engine lathes, shaping machines, etc., with dimensions. 6 by 9 in.; pp. 32.

Mine Equipment.

MONONGAHELA MFG. CO., Monongahela.—Catalogue illustrating and describing haulage and hoisting engines, tipples, mine cars, crushers, etc. 6 by 9 in.; pp. 36.

Motor Cars.

ADAMS CO., Dubuque, Iowa.—Catalogue devoted to an illustrated description of the Adams-Farwell motor car. 6 by 9 in.; pp. 16.

Motors.

ALLIS-CHALMERS CO., Milwaukee.—Bulletin No. 1040 illustrates and describes polyphase induction motors. Bulletin No. 1045 treats of rotary converters.

Packing.
MECHANICAL RUBBER CO., Cleveland.—Catalogue describing the various qualities of packings, together with tables giving sizes, weights and prices. Illustrated. 5 by 7½ in.; pp. 60.

Pipe Tools.
TRIMONT MFG. CO., Roxbury, Mass.—Catalogue illustrating and describing pipe tools and accessories. 9 by 6 in.; pp. 16.

Power Presses.
PERKINS MACHINE CO., Warren, Mass.—Well-printed catalogue illustrating and describing a large number of power presses. 5½ by 8 in.; pp. 176.

Pulverizers.
KENT MILL CO., New York.—Pamphlet devoted to an illustrated description of pulverizing machinery.

Pumping Machinery.
AMERICAN WELL WORKS, Aurora, Ill.—Illustrated bulletin treating of pumping machinery for all purposes. 8 by 11 in.; pp. 32.

Pumps.
W. & B. DOUGLAS, Middletown, Conn.—Illustrated catalogue describing hand and power pumps, hydrants, well fixtures, etc. 6 by 9 in.; pp. 190.

Punching Machines.
CINCINNATI PUNCH & SHEAR CO., Cincinnati.—Catalogue treating punching and shearing machinery, rolls, etc. Illustrated. 6 by 9 in.; pp. 56.

Pyrometers.
EDWARD BROWN & SON, Philadelphia.—Catalogue devoted to an illustrated description of pyrometers, together with price list. Also contains a partial list of users. 7½ by 10½ in.; pp. 32.

Ore Cars.
WATT MINING CAR WHEEL CO., Barnesville, O.—Booklet containing a brief description of different styles of ore cars. 3 by 6 in.; pp. 12.

Radial Drills.
BICKFORD DRILL & TOOL CO., Cincinnati.—Well-printed catalogue illustrating and describing radial drills of all kinds. 6 by 9 in.; pp. 42.

Saws.
JAMES OHLEN & SONS, Columbus.—Catalogue devoted to an illustrated description of circular, band, hand and cross cut saws. Also gives sizes and prices. 5 by 7 in., pp. 84.

Separators.
BAUM SEPARATOR & MACHINE CO., Manheim, Pa.—Illustrated catalogue containing a brief description of several styles of live steam and oil separators. 6 by 9 in.; pp. 26.

Steam Engines.
MESTA MACHINE CO., Pittsburg.—Cloth bound catalogue illustrating and describing Corliss and piston-valve engines. Rolling mill machinery and machine-molded gears are also treated. 12 by 9 in.; pp. 128.

Steam Shovels.
TOLEDO FOUNDRY & MACHINE CO., Toledo.—Catalogue containing an illustrated description of steam shovels and dipper dredges. Land dredges, centrifugal pumps and railroad pile drivers are also treated. 9 by 6 in.; pp. 82.

Tapping Machines.
MODERN TOOL CO., Erie.—Pamphlet treating of tapping machines for gas, steam and water mains. Also water works supplies. 6 by 9 in.; pp. 16.

Traveling Cranes.
NORTHERN ENGINEERING WORKS, Detroit.—Booklet treating of traveling cranes, hoists, cupolas, etc. Illustrated. 5½ by 3¼ in.; pp. 16.

Twist Drills.
NEW PROCESS DRILL CO., Taunton, Mass.—Catalogue illustrating and describing twist drills, together with tables giving sizes and prices. 6 by 9 in.; pp. 30.

Valves.
GOLDEN-ANDERSON VALVE SPECIALTY CO., Pittsburg.—Pamphlet illustrating and describing non-return, reducing, automatic and counterbalanced and float valves. Steam traps are also treated. 5 by 7½ in.; pp. 48.

Water Filters.
NEW YORK CONTINENTAL JEWELL FILTRATION CO., New York.—Catalogue illustrating and describing the different styles and sizes of filters, together with tables giving capacities. 9 by 6 in.; pp. 48. Also a pamphlet containing an illustrated description of the filtration equipment installed for the East Jersey Water Co., Little Falls, N. J. 6 by 9 in.; pp. 36.

Water Turbines.
JAMES LEFFEL & CO., Springfield, O.—Pamphlet P contains an illustrated description of water turbines, together with tables giving much valuable data. 9 by 6 in.; pp. 52. Catalogue O treats of engines and boilers. 9 by 6 in.; pp. 52.

Water Wheel Governors.
LOMBARD-REPLOGLE ENGINEERING CO., Akron.—Folder illustrating and describing water wheel governors. 6 by 9 in.; pp. 4.

Wire Glass.
CONTINUOUS GLASS PRESS CO., Philladelphia.—Catalogue containing illustrations, with brief descriptions, of many styles of wire glass. 6 by 9 in.; pp. 16.

Wire Lath.
CLINTON WIRE CLOTH CO., Clinton, Mass.—Cloth bound catalogue containing descriptions, specifications and applications of wire lath. 6 by 9 in.; pp. 52.

Woodworking Machinery.
FRANK MACHINERY CO., Buffalo.—Catalogue illustrating and describing woodworking machinery. 10 by 6½ in.; pp. 96.

SENECA FALLS MFG. CO., Seneca Falls, N. Y.—Catalogue describing foot, hand and light power woodworking machinery. 9 by 6 in.; pp. 24. Also a catalogue treating lathes and accessories. 9 by 6 in.; pp. 32.

Wrenches.
J. H. WILLIAMS & CO., Brooklyn.—Well-printed catalogue containing an illustrated description of wrenches, together with sizes and prices. 5 by 7½ in.; pp. 114.